DR/2010 SPECTROPHOTOMETER

INSTRUMENT MANUAL

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The DR/2010 Spectrophotometer has been tested, and is certified as indicated to the following instrumentation standards.

Product Safety

Battery eliminator power supply only:

UL Listed

CSA Certified

CE Marked, GS Licensed

Immunity

Instrument tested with external battery eliminator power supply:
EN 50082-1 (1997) European Generic Immunity Standard per 89/336/EEC EMC- supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

EN 61000-4-2 “1995” (IEC 1000-4-2) Electro-static discharge

EN 61000-4-3 “1995” (IEC 1000-4-3) Radiated RF electromagnetic fields

EN 61000-4-4 “1995” (IEC 1000-4-4) Electrical Fast Transient/burst

EN 61000-4-5 “1995” (IEC 1000-4-5) Surge

EN 61000-4-6 “1996” (IEC 1000-4-6) Conducted disturbances induced by RF fields

EN 61000-4-11 “1994” (IEC 1000-4-11) Voltage Dips, Interruptions and Variations

ENV 50140 “1993” (IEC 801-3) Radiated RF Electro-magnetic fields

ENV 50141 “1993” Conducted disturbances induced by RF fields

ENV 50204 “1995” Radiated Electro-magnetic field from digital phones

Emissions

Instrument tested with external battery eliminator power supply:
EN 50081-1 (1992 Emissions) per 89/336/EEC EMC: Supporting test records by Intellistor OATS, certified compliance by Hach Company.

Standards include:

EN 55022 (CISPR 22) Emissions, Class B limits

EN 61000-3-2 Harmonic disturbance caused by electrical equipment

EN 61000-3-3 Voltage fluctuation (Flicker) disturbances caused by electrical equipment

Canadian Interference-Causing Equipment Regulation, IECS-003, Class A:
Supporting test records by Intellistor OATS, certified compliance by Hach.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada."

FCC Part 15Class “A” Limits: Supporting test records by Intellistor OATS, certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:
(1) this device may not cause harmful interference

(2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect power from the DR2010 instrument to verify that is the source of the interference.
2. If the DR/2010 Instrument is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the DR/2010 away from the device receiving the interference.
4. Reposition the receiving antenna of the device receiving the interference.
5. Try combinations of the above.

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SPECIFICATIONS

(Specifications subject to change without notice)

Wavelength Range: 400 - 900 nm

Spectral Bandwidth: 7 nm nominal @ 600 nm

Wavelength Accuracy: ±2 nm from 400-700 nm; ±3 nm from 700-900 nm

Wavelength Resolution: 1 nm

Monochromator Design: Littrow Prism, Aspheric Optics

Wavelength Selection: Manual

Wavelength Readout: 3-digit LCD, 0.5-cm Character Height

Photometric Linearity: ±0.002 A (0-1 A 546 nm - constant on mode)

Photometric Reproducibility: ±0.005 A (0-1 A - constant on mode)

Source Lamp: Halogen Tungsten

Detector: Silicon Photodiode, UV enhanced

Data Readout: 4-digit LCD, 1.5-cm Character Height

Message Display: 16 character LCD dot-matrix, 0.6-cm Character Height

Operation Modes: Momentary, Constant On

Readout Modes: Transmittance, Absorbance, Concentration

Readout Languages: Selectable by menu- English, French, Spanish, German, Dutch, Portuguese, and Japanese

External Outputs: RS-232 Serial with handshaking (printer optional), 9 pin RS232 connector

Line Power: Automatically switches for 95-240 ±10% Vac; 50/60 Hz

Battery Power: Rechargeable 8 V sealed lead-acid (optional) or 6-battery "D" Cell Pack. Holder supplied.

Dimensions: 22 x 24 x 11 cm (8.75 x 9.5 x 4.375 in)

Weight: Net: 2 kg (4.5 lb) Shipping: 6.8 kg (15 lbs)

Dynamic Range: 0-2 A (100:1)

Stray Light: < 1.0% at 400 nm

Bulb Life: 2,000 hours, >1,000,000 measurement cycles

Battery Life (rechargeable): 1000 measurement cycles per complete battery charge. Charger included.

Battery Weight (rechargeable): Net:1.1 kg (2.5 lbs); Shipping: 2.2 kg (5 lbs)

Temperature Range: 0-40 °C (32-104 °F) operating range

Storage Range: -40 to 60 °C (-40 to 140 °F)

SAFETY PRECAUTIONS

Before attempting to unpack, set up or operate this instrument, please read this entire manual. Pay particular attention to all warnings, cautions and notes. Failure to do so could result in serious injury to the operator or damage to the equipment.

Use of Hazard Information
If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

DANGER
Indicates either a potentially or an an imminently hazardous situation which, if not avoided, could result in either death or serious injury

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury

NOTE
Information that requires special emphasis

Precautionary Labels
Please pay particular attention to labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

This symbol, if noted on the instrument, references the Instruction Manual for operational and/or safety information.

2.4 Installing and Using the Pour-Thru Cell

3.0 Instrument Operation

OPERATION

DANGER
Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

PELIGRO
La manipulación de muestras químicas, patrones y reactivos puede ser peligrosa. Antes de manipular cualquier productor químico, conviene leer las Fichas Técnicas de Seguridad y familiarizarse con los procedimientos de seguridad.

PERIGO
A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja as necessárias Fichas Técnicas de Segurança do Material e familiarizese com os procedimentos de segurança antes de manipular quaisquer substãncias químicas.

DANGER
La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les fiches de données de sécurité des produits nécessaires et se familiariser avec toutes les procédures de sécurité avant de manipuler tout produit chimique.

GEFAHR
Da das Arbeiten mit chemikalischen Proben, Standards, Reagenzien und Abfällen mit Gefahren verbunden ist, empfiehlt die Hach Company dem Benutzer dieser Produkte dringend, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien oder Biogefahrgut vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

SECTION 1 GENERAL DESCRIPTION

1.1 Instrument Description

The Hach Model DR/2010 Spectrophotometer shown in *Figure 1* is a microprocessor-controlled, single-beam instrument for colorimetric testing in the laboratory or the field. The instrument is precalibrated for over 120 different colorimetric measurements and allows convenient calibrations for user-entered and future Hach methods.

Instrument features include:

- Test results displayed in percent transmittance, absorbance or concentration.
- Data Storage and Recall for datalogging in the field or laboratory.
- Operator-selected languages.
- Full prompting during testing.
- Error messages for procedural or instrument troubleshooting.
- A built-in timer to monitor specific reaction times called for in the test procedures. The appropriate time intervals are stored in the program for that test. The timer also can be used manually by the operator independent of the stored programs.
- RS232 interface capability allows an external printer or computer to interface with the spectrophotometer. This makes software upgrades easy to do with a computer and software disk from Hach.
- Simplified entry of user-entered programs or new Hach methods.

The spectrophotometer operates on battery power or ac line power using the battery eliminator/charger unit supplied with the accessories. The battery holder supplied holds six D-size alkaline dry cells (batteries not supplied) that power the instrument for approximately 100 tests. An optional rechargeable lead-acid battery is available, and can be recharged with the battery eliminator/charger supplied with the instrument. The eliminator/charger will not charge rechargeable D-size batteries.

CAUTION
Do not use or store the lead-acid battery above 60 °C or the battery may leak. Use D-cell batteries instead.

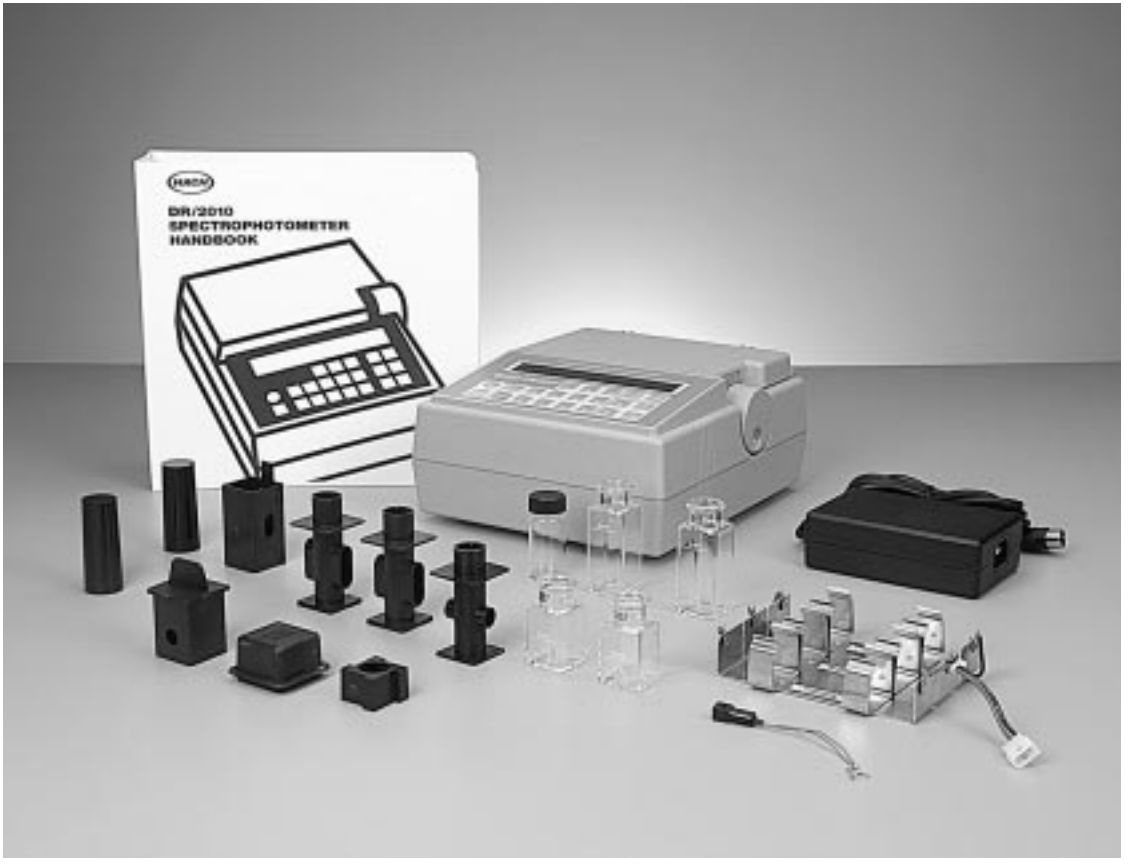
CUIDADO
No utilizar o almacenar la bateria de ácido de plomo a una temperatura supérior a 60 °C ya que esto puede producir un excape en la bateria. Utilizar en su lugar una bateria de pila seca.

CUIDADO
Não utilize nem armazene a bateria de ácido-chumbo em temperaturas superiores a 60 °C, pois podem ocorrer vazamentos. Use, ao invés disso, baterias secas tipo D.

PRUDENCE
Ne pas utiliser ou stocker la batterie plomb-acide au-dessus de 60 °C, sinon la batterie rique de fuir. Utiliser les piles taille D.

WARNHINWEIS
Der Bleiakkumulator darf nicht über 60 °C benutzt oder gelagert werden, da er sonst auslaufen kann. Benutzen Sie alternativ die D-Zellen.

Figure 1
DR/2010 Spectrophotometer



1.2 Accessories

Accessories supplied with the DR/2010 Spectrophotometer include:

- Dust Cover
- Sample Cell Adapters:
  - Immunoassay
  - 13 mm Test Tube
  - 16 mm (COD and Test ‘N Tube vials)
  - AccuVac®
  - Cell Riser (for 10-mL sample cells)
- Sample Cells:
  - Round Zeroing Vial (for use with AccuVacs)
  - Matched 1-inch square, 25 mL
  - Matched 1-inch square, 10 mL
- Illustrated Procedure Manual and Instrument Manual
- Battery Holder
- Light Shield Cap
- Spare Lamp
- Calibration Filter, 808 nm
- Battery Eliminator/Charger

1.2.1 Optional Accessories

- 1-inch Pour-Thru Cell
- 1-cm Pour-Thru Cell
- 1-cm Matched Sample Cells
- 1-cm Cell Adapter
- Portable Printer
- Printer Accessories
  - Ink Cartridge
  - Rechargeable Battery Pack
  - Printer Cable
  - EEC Style Plug Adapter
- Carrying Case
- Rechargeable Lead-Acid Battery
- HachLink™ Software
- RS232 Computer Interface Cable

In addition to these accessories, several other optional accessories are available from Hach Company (refer to *Replacement Parts*).

SECTION 2 INSTRUMENT/ACCESSORY SETUP

2.1 Unpacking

Remove the instrument and all accessories from the shipping container and inspect each item for any damage that may have occurred due to rough handling or extreme weather conditions during shipment. Verify that the items listed in section *1.2 Accessories* are included. If any items are missing or damaged, please contact Hach Customer Service, Loveland, Colorado for instructions. The toll-free number is 1-800-227-4224. For customers outside the United States, contact the Hach office or distributor serving you.

2.2 Supplying Operating Power

2.2.1 Battery Eliminator/Charger

If line power is used, connect the battery eliminator/charger (power supply) cable plug to the **POWER** connector on the back of the instrument, and plug eliminator/charger power cord into the power receptacle (see *Figure 11*).

Note: *For safety and performance never operate the DR/2010 without the battery and lamp covers closed.*

When the battery eliminator/charger is connected and operating, the instrument operates on line power only and the battery will not power the instrument. If the optional rechargeable battery is installed, the instrument will operate and the battery will be charged simultaneously.

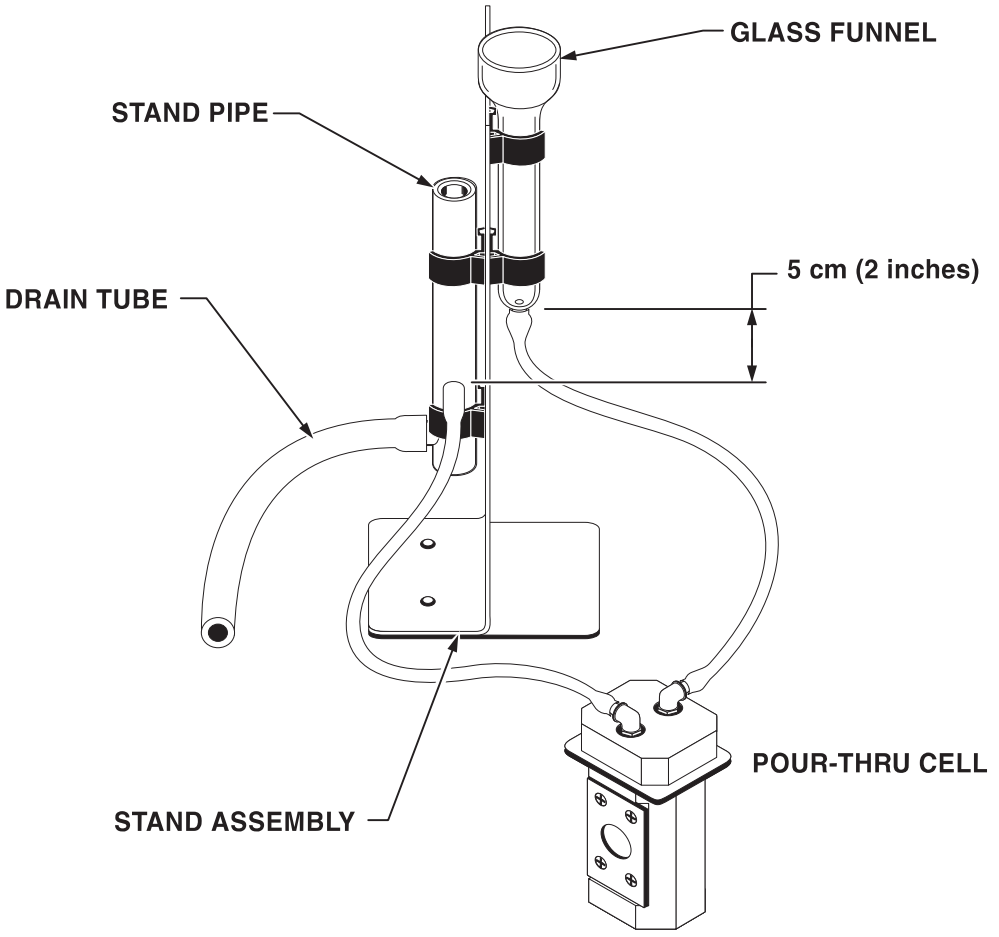
This power supply will operate on line voltages from 95 Vac to 240 Vac. Power supply voltage selection is automatic, no user interaction is required.

2.3 Assembling the Pour-Thru Cell

The 1-inch and 1-cm Pour-Thru sample cells are optional accessories that improve convenience and accuracy, especially when measuring very low concentrations. Because the same optical characteristics exist for both zeroing and measuring, or when comparing measurements of different samples, any error resulting from optical differences between individual sample cells is eliminated. Rapid Liquid methods speed analysis and require use of the Pour-Thru Cell (see the procedure manual for these programs).

The optional Pour-Thru Cell Assembly must be assembled and installed before use. *Figure 2* illustrates the assembled unit.

Figure 2
Pour-Thru Cell Assembly



The kit includes:

- Pour-Thru Cell (1-inch or 1-cm)
- Stand Assembly
- Glass Funnel
- Stand Pipe
- 1/8″ ID plastic tubing (6 ft)
- 1/4″ ID rubber tubing (12 ft)
- Instruction Sheet

CAUTION

Do not use the Pour-Thru Cell in tests that call for the use of organic solvents such as toluene, chloroform, trichloroethane or cyclohexanone. These solvents may not be compatible with the plastic components of the Pour-Thru Cell creating the potential for equipment damage and chemical exposure for the analyst.

ADVERTENCIA

No utilice la Célula de Flujo Continuo para pruebas que requieran el uso de solventes orgánicos tales como tolueno, cloroformo, tircloretano o ciclohexanona. Es posible que estos solventes sean incompatibles con los componenetes de material plástico de la Célula de Flujo Continuo y existe el riesgo de daños al equipo y exposición del analista a las substancias químicas.

CUIDADO

Não use a Cubeta de Fluxo em testes que exigem o uso de solventes orgânicos como tolueno, clorofórmio, tricloroetano ou ciclohexanona. Estes solventes podem não ser compatíveis com os componentes plásticos da Cubeta de Fluxo, havendo a possibilidade de danos ao equipamento e exposição do analista a substâncias químicas.

ATTENTION

Ne pas utiliser la cuve à circulation dans les techniques d'analyses qui utilisent des solvants organiques tels que le toluène, le chloroforme, le trichloroéthane ou la cyclohexanone. Les solvants organiques peuvent ne pas être compatibles avec les composants en plastique de la cuve à circulation et endommager l'équipement en créant un risque chimique pour l'opérateur.

WARNHINWEIS

Die "Pour-Thru-Zelle" darf nicht in Tests verwendet werden, die organische Lösungsmittel wie Toluol, Chloroform, Trichlorethan oder Cyclohexanon erfordern. Die Möglichkeit besteht, daß diese Lösungsmittel nicht mit den Kunstoffkomponenten der "Pour-Thru-Zelle" kompatibel sind und somit Geräteschaden verursachen und eine Chemikaliengefahr für den Untersuchungschemiker darstellen können.

2.4 Installing and Using the Pour-Thru Cell

Install the Pour-Thru cell in the spectrophotometer as follows:

1. Examine the glass windows in the Pour-Thru cell. If they are dirty or smudged, clean with a soft, lint-free cloth or optical tissue.

2. Insert the Pour-Thru cell into the instrument cell holder with the windows aligned with the windows in the cell holder (see *Figure 2* and *Figure 3*). The inlet and outlet ports should point toward the front with the inlet tube on the left. Be sure the Pour-Thru cell is fully inserted to prevent any light leakage around the gasket. The cell compartment cover can remain open when using this accessory.

3. Adjust the relative heights of the stand pipe and funnel to ensure proper drainage for the funnel. The funnel drains completely with the final level of liquid in the tube, about 5 cm (2 inches) below the tip of the funnel. Initially, adjust the stand pipe so that the inlet is 5 cm below the tip of the funnel (see *Figure 2*).

4. Pour 25 to 50 mL of demineralized water into the funnel and allow the funnel to drain. If necessary, move the stand pipe up or down to achieve the proper liquid level. When properly adjusted, the funnel drains smoothly and stops draining at the correct level.

Figure 3 Installing the Pour-Thru Cell

The drain tube attached to the stand pipe must drain freely. It should always remain below the outlet of the stand pipe, and should not run horizontally any more than necessary. Preferably, the tube should be as short as possible with the outlet end inserted into a drain (or suitable collecting vessel if treatment is necessary before discharge).

The 1-inch and 1-cm Pour-Thru Cells have slightly different optical properties and purge volumes as shown in the following table.

Table 1 Pour-Thru Cell Differences

Cell	Minimum Purge Volume
1 cm	**20 mL** to keep the Abs reproducibility within ±0.002 Abs when increasing the sample concentration from 0.000 to 1.600 Abs or decreasing the sample concentration from 1.600 to 0.000 Abs. (at 548 nm)
1 inch	**22 mL** to keep the Abs reproducibility within ±0.002 Abs when increasing the sample concentration from 0.000 to 2.000 Abs or decreasing the sample concentration from 2.000 to 0.000 Abs. (at 548 nm)

The 10-mL procedures cannot be used with the 1-inch Pour-Thru Cell as 10 mL is not enough to completely flush out the previous sample. Procedures with 10 mL as the final volume include optional 25-mL reagents so the Pour-Thru Cell may be used when feasible.

2.5 Sample Cell Adapter Installation

The light path is from right to left as you view from the front of the instrument. When placing one of the adapters into the cell holder, line the light path ports in the adapters facing right and left. All of the adapters can be rotated 180 degrees with no affect on the optics. For a list of the available adapters, refer to *REPLACEMENT PARTS*.

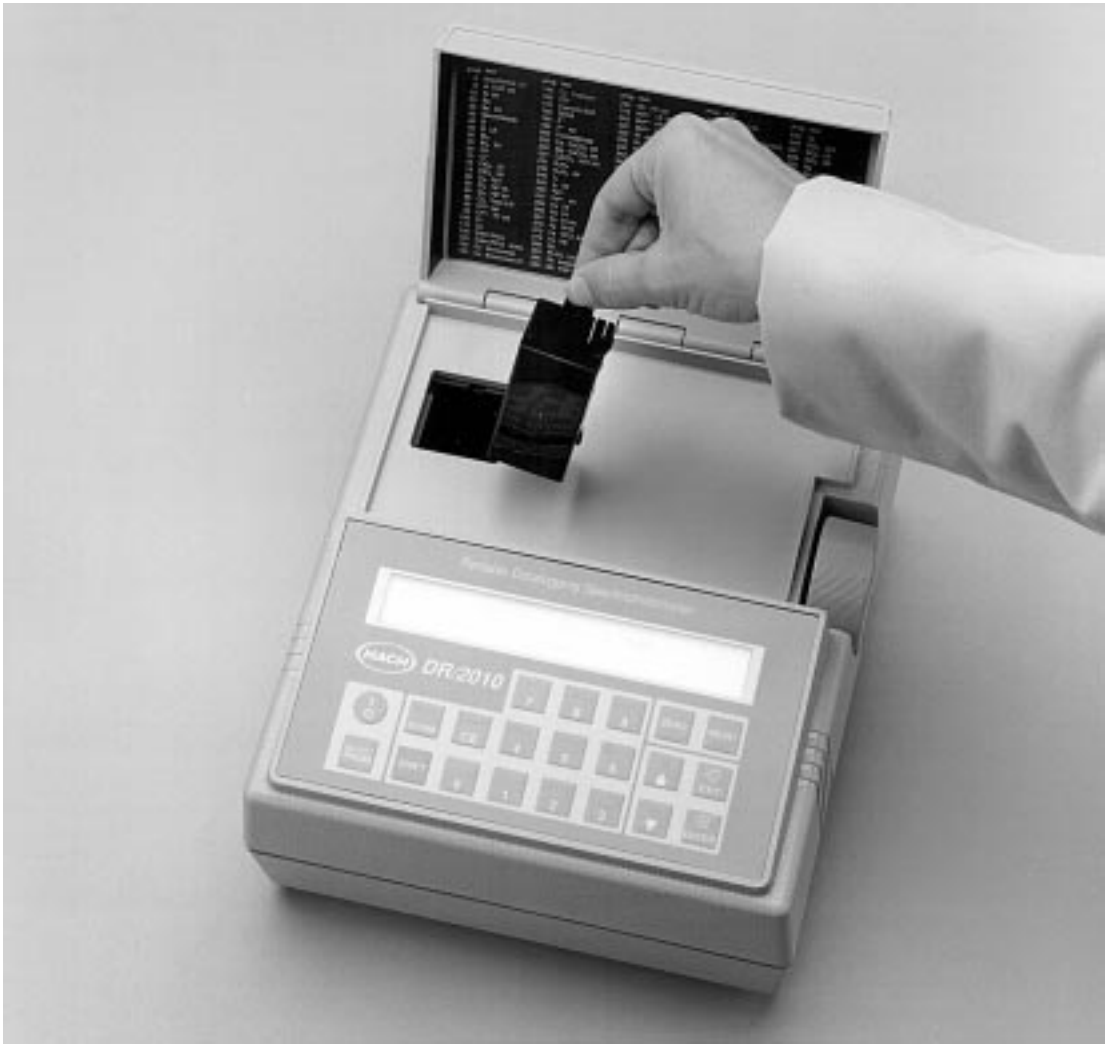
2.5.1 Using the AccuVac Vial Adapter

Hach Company's AccuVac Ampul reagents can be used in the DR/2010 Spectrophotometer with the aid of the adapter provided in the accessories. Test procedures for AccuVac reagents are included in the procedure manual and in the method list on the underside of the cell compartment cover (AV denotes an AccuVac procedure). If using the instrument in direct sunlight, use the light shield cap to cover the cell holder.

Reagents are contained in sealed, evacuated vials and are mixed with the water sample by partially immersing the ampul and breaking off the tip to allow sample to be drawn in. Reacted sample is measured in the ampul once the adapter is installed in the instrument. For proper orientation of the adapter in the sample cell compartment, place the grip tab of the adapter toward the back of the compartment (see *Figure 4, Installing AccuVac Vial Adapter*).

The AccuVac Adapter is also used for chemistries using the 10-mL round sample cells (e.g., monochloramine).

Figure 4
Installing AccuVac Vial Adapter



2.5.2 Using the COD/TNT Vial Adapter

The methods for chemical oxygen demand (COD) and Test ‘N Tube (TNT) procedures in the DR/2010 Procedures Manual use 16 mm vials as the sample cell for the colorimetric measurement. Place the vials into the COD/TNT Vial Adapter after it is installed in the cell compartment (see *Figure 5*). This adapter also holds standard 16-mm test tubes.

Place the COD/TNT Vial Adapter in the instrument's sample cell compartment with the orientation mark toward the left. The light shield cap included with the adapter must be in place when measuring samples. The cell compartment cover remains open.

Figure 5 Installing the COD/TNT Adapter

2.5.3 Using the Immunoassay Tube Adapter

Immunoassay methods develop and read the color in special antibody coated tubes. The instrument can read immunoassay results with the aid of the Immunoassay Tube Adapter provided in the accessories. Place the tubes into the adapter after it is installed in the cell compartment. The adapter openings must face right and left when you install it in the compartment (see *Figure 6*). Always place the light shield cap over the adapter when measuring (the cell compartment cover will remain open).

Figure 6
Installing the Immunoassay Tube Adapter

2.5.4 Using the 13-mm Test Tube Adapter

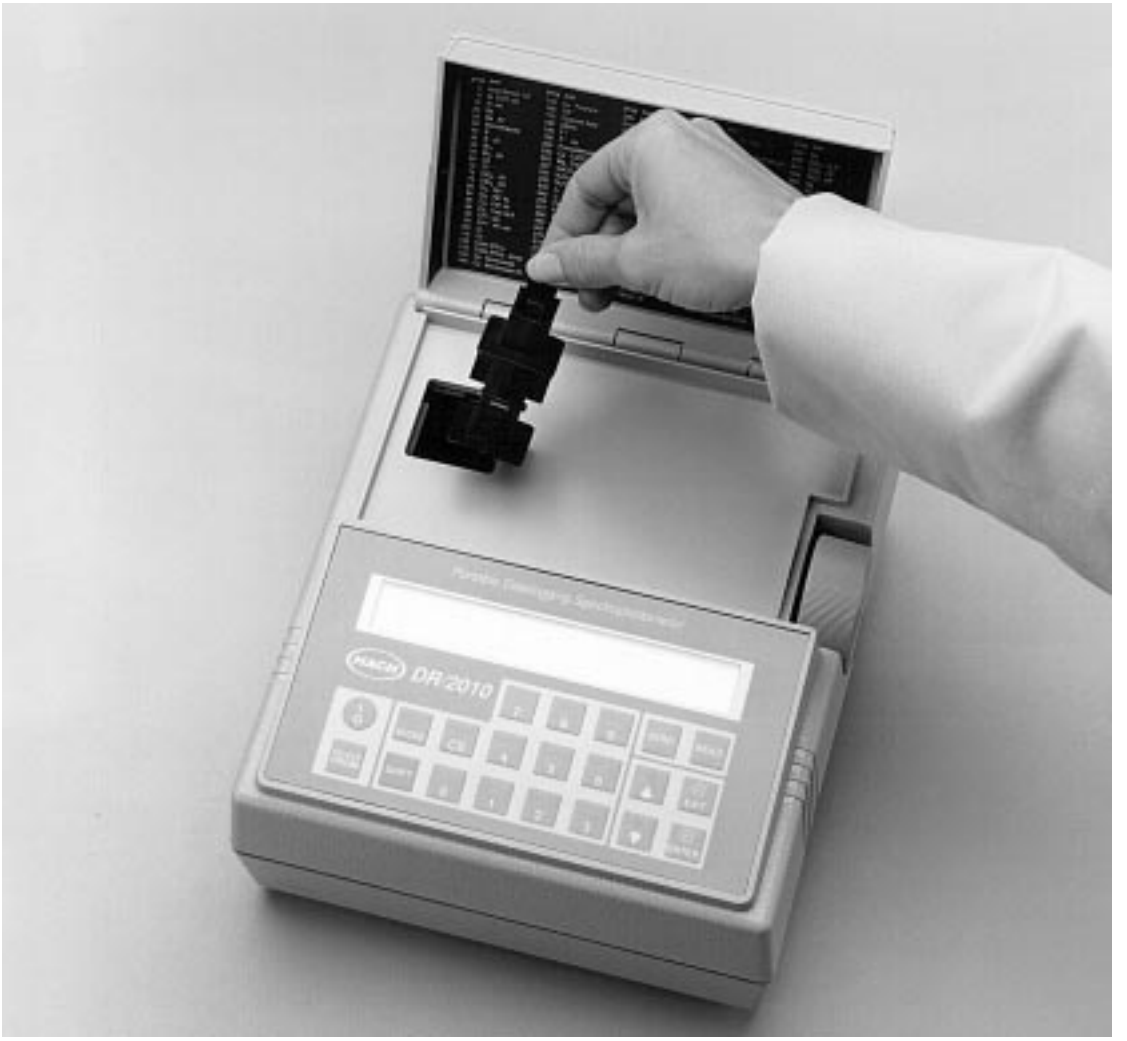
This test tube adapter is placed in the instrument cell holder with the orientation mark to the right (see *Figure 7, Installing the Test Tube Adapter*). Proper placement is necessary to match the left-to-right light path. Because of the height of the test tube, the adapter comes with its own light shield cap that must be in place when readings are taken. The cell compartment cover remains open.

Figure 7
Installing the Test Tube Adapter

2.5.5 Using the 1-cm Cell Adapter

Use standard 1-cm square cuvettes with the DR/2010 Spectrophotometer when Hach's 1-cm adapter (optional accessory) is installed. Glass 1-centimeter cuvettes are not supplied with the instrument, but are optional accessories in optically matched pairs. Quartz 1-cm cells are not necessary for the instrument because the spectrophotometer does not measure in the UV range (but they will work well if used).

Figure 8 Installing the 1-cm Cell Adapter



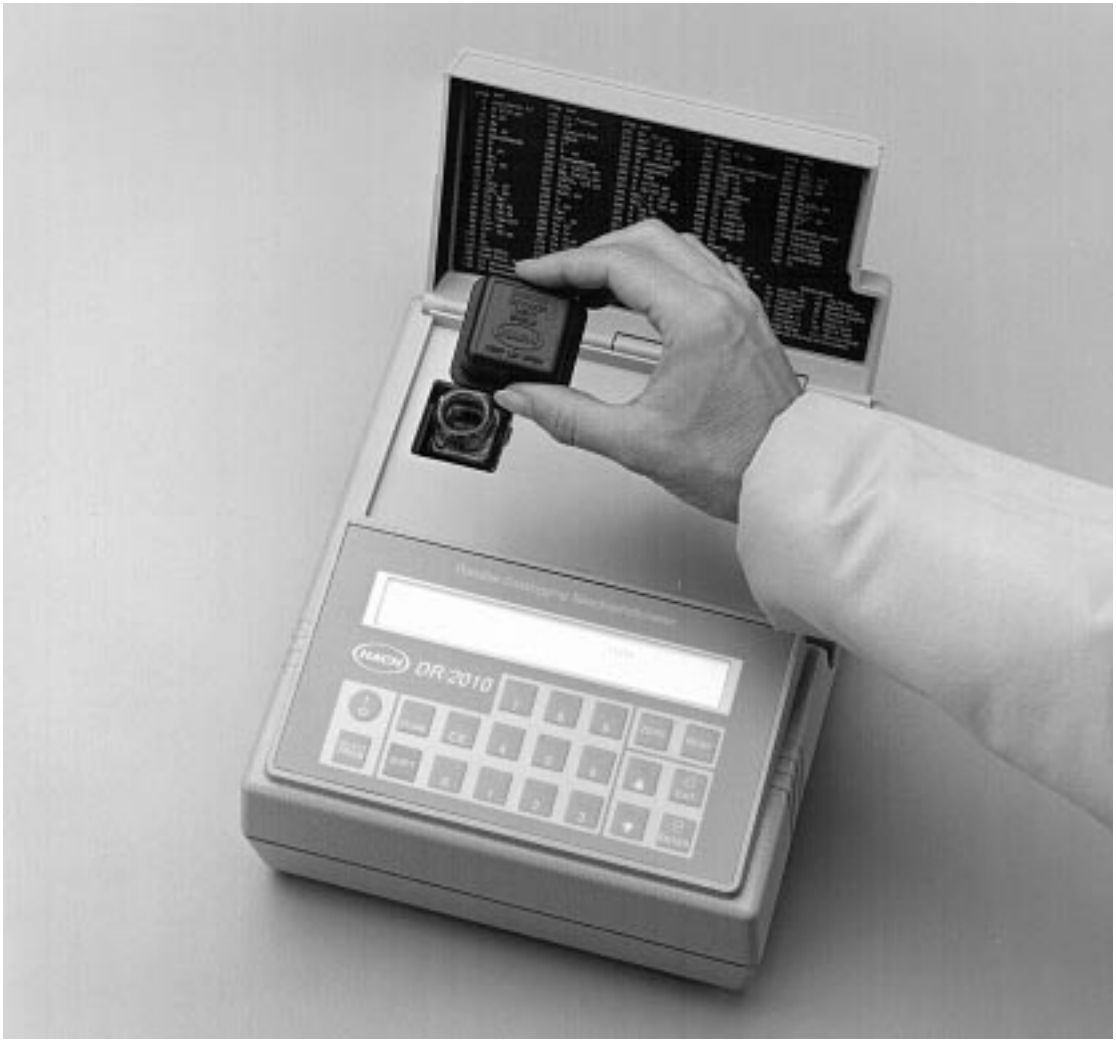
Place the adapter in the instrument cell compartment with the handling tab to the rear (see *Figure 8*). This orients the adapter correctly in the light path. When using glass cuvettes, place them in the adapter with the clear sides in the right-to-left optical path. Close the cell compartment cover

while taking readings. If operating the instrument in direct sunlight, cover the cell holder with the light shield cap supplied with the accessories.

2.6 Using the Light Shield Cap

The light shield cap, supplied with the accessories, can be used instead of closing the cell compartment cover, and always should be used when operating the instrument in direct sunlight (refer to *Figure 9*).

Figure 9 Installing the Light Shield Cap

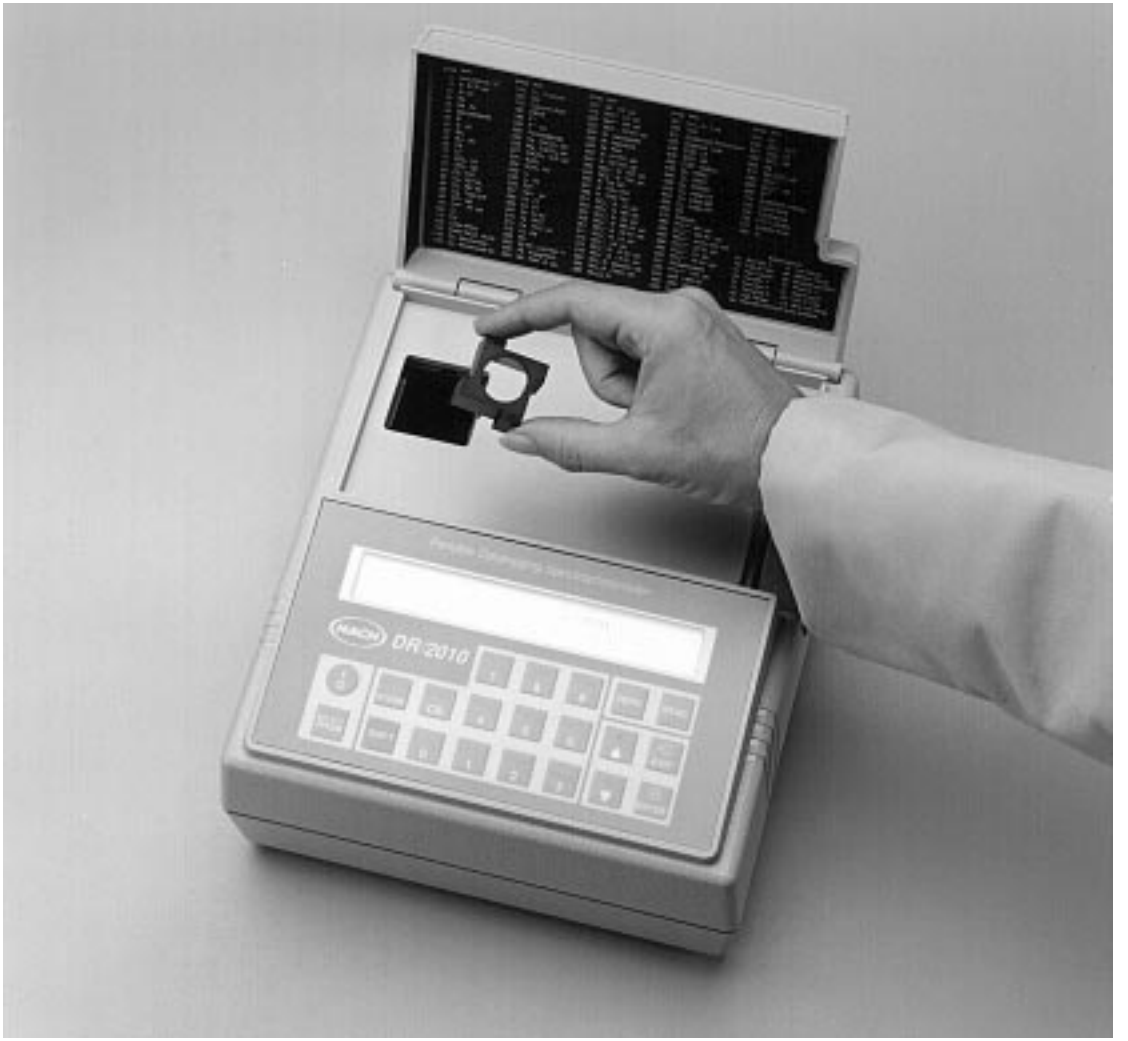


2.7 Using the Cell Riser for 10-mL Cells

Two sizes of 1-inch square sample cells are supplied with the instrument, the shorter 10-mL size and the taller 25-mL size. Both sizes are matched and have fill lines that should face the viewer's left in the instrument.

The 10-mL size sample cells require a Cell Riser to elevate them so the liquid sample is in the spectrophotometer light beam (see *Figure 10*).

Figure 10 Inserting the 10-mL Cell Riser



2.8 RS232 Connections

All RS232 connections are made using the serial I/O port on the back of the instrument (see *Figure 11*). This port uses an industry standard 9-pin connector. See section *4.2 RS232 Connection* for information on installing the RS232 cable.

Note: *For optimum performance and ESD protection, use a three-conductor shielded cable. Use a metal shell for the printer or CRT terminal connector, and connect the shield of the cable to the metal shell and to the sleeve (signal ground) of the RS232 plug.*

Press the **SHIFT PRINT** keys to send data to the printer. See section *3.7 Printing Data* for instructions.

2.8.1 Setup and Use of the Citizen Printer

Follow all of the manufacturer's instructions shown on the printer and in the printer manual when configuring for compatibility with the DR/2010 Spectrophotometer. A permanent record of test results is obtained by using the RS232 serial output to drive a printer.

Figure 14 on page 54 illustrates the printout from the eighty-column printer listed in the optional accessories in REPLACEMENT PARTS on page 99. Pressing **SHIFT PRINT** manually starts the printing (refer to section *3.7 Printing Data).*

Connect the DR/2010 Spectrophotometer to the Citizen PN60 printer using the serial printer interface cable, that is shipped with the Citizen PN60 printer. The cable provides a direct link between the instrument and the connector used for the serial port on the portable printer. See *Table 2* and *Table 3* if you need to wire a cable for special applications.

Table 2 Standard 9-pin to 9-pin Computer Cable

DR/2010 9-pin D Connector Socket		Computer 9-pin D Connector, plug	
Pin	Signal Name	Pin	Signal Name
2	RXD	3	TXD
3	TXD	2	RXD
4	DTR	no connection	
5	GND	5	GND
6	DSR	no connection	
7	RTS	8	CTS
8	CTS	7	RTS

Table 3 Standard 9-pin to 25-pin Printer Cable

DR/2010 9-pin D Connector Socket		Serial Printer 25-pin D Connector, plug	
Pin	Signal Name	Pin	Signal Name
2	RXD	no connection	
3	TXD	3	RXD
4	DTR	no connection	
5	GND	7	GND
6	DSR	20	DTR
7	RTS	no connection	
8	CTS	20	DTR

To print, the communication parameters (baud rate, data bits and parity) of the DR/2010 Spectrophotometer and the printer must match. The instrument default settings for printing are baud = 9600; parity = none; bits = 8. See *3.2.1 Using the Setup Menu,* to select other Serial I/O settings.

Default settings of the instrument match the default settings on the Citizen PN 60 Printer with the exception of the serial interface (serial I/O) protocol setting. Change the protocol setting from XON/XOFF to DTR in the Citizen Printer setup menu (see the printer manual for instructions).

The tabular format of the DR/2010 Spectrophotometer is compatible with serial printers that are at least 80 characters wide. Graphics can only be printed in printers that are directly compatible with an Epson LQ-570+ or Citizen PN-60 printer. See *3.7 Printing Data* for more details.

2.8.2 Connecting to a PC

The DR/2010 Spectrophotometer requires a special cable (Cat. No. 48129-00) to connect the instrument to a personal computer (see Optional Accessories in REPLACEMENT PARTS on page 99.) The cable provides a direct link between the DR/2010 Spectrophotometer and the 9-pin D connector used for the serial port on most personal computers. If your computer has a 25-pin D connector, use a 9-pin to 25-pin adapter (available at most computer supply stores). See *Table 2* and *Table 3* if you need to wire a cable for special applications.

The PC must have software that can accept the data from the DR/2010 Spectrophotometer (i.e., Windows™ Terminal, HachLink™...).

The communication parameters (baud rate, data bits and parity) of the DR/2010 Spectrophotometer and the computer must match.
See section *3.2.1 Using the Setup Menu,* to select the Serial I/O settings.

Once the communication link is established, press **SHIFT PRINT** to send data to the computer. Do not send graphics directly to the computer; send all data in tabular form. This link is also used to install software upgrades from a personal computer to the instrument.

2.8.3 Additional Interface Information

Depending on the interface application, it may be necessary to know the following:

- The DR/2010 Spectrophotometer sends one stop bit.
- A carriage return and line feed character are sent at the end of each line.
- The DR/2010 Spectrophotometer uses hardware handshaking.

2.9 HachLink Software

Note: *DR/2010s require HachLink software version 1.2 or later.*

HachLink™ Software is a Windows™ application that allows a personal computer to capture data from a variety of Hach laboratory instruments, including the DR/2010 Spectrophotometer. The captured data can be stored in a text file either in spreadsheet-compatible format or free-format text. Data collected using the spreadsheet format is easily transferred into most spreadsheet programs (such as Microsoft® Excel, Microsoft® Works, etc.) for graphing and reporting.

To install and run HachLink™ Software, the computer and software must meet the following minimum requirements:

- IBM® PC/AT or compatible with a 386SX processor (16 MHz or better)
- 4 megabytes of RAM
- Hard disk drive with 2 megabytes or more of free space
- 3-1/2 inch, 1.44 megabyte floppy disk drive
- VGA graphics with 640 x 480 or higher resolution, 16 or more colors
- Mouse or other pointing device
- A 9-pin serial port (or 25-pin serial port with 9-pin adapter)
- Windows 3.1 or later
- DOS 3.3 or later

See complete instruction for installing and using the HachLink™ Software in the manual that comes with the software disk.

SECTION 3 INSTRUMENT OPERATION

DANGER
This instrument is not intended for use with flammable samples or those containing hydrocarbons.

PELIGRO
Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

PERIGO
Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

DANGER
Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

GEFAHR
Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

3.1 Description of Operating Controls

Figure 11 shows the spectrophotometer controls, indicators and connections. Their functional descriptions are in *Table 4.*

Figure 11
Operating Controls, Indicators And Connectors

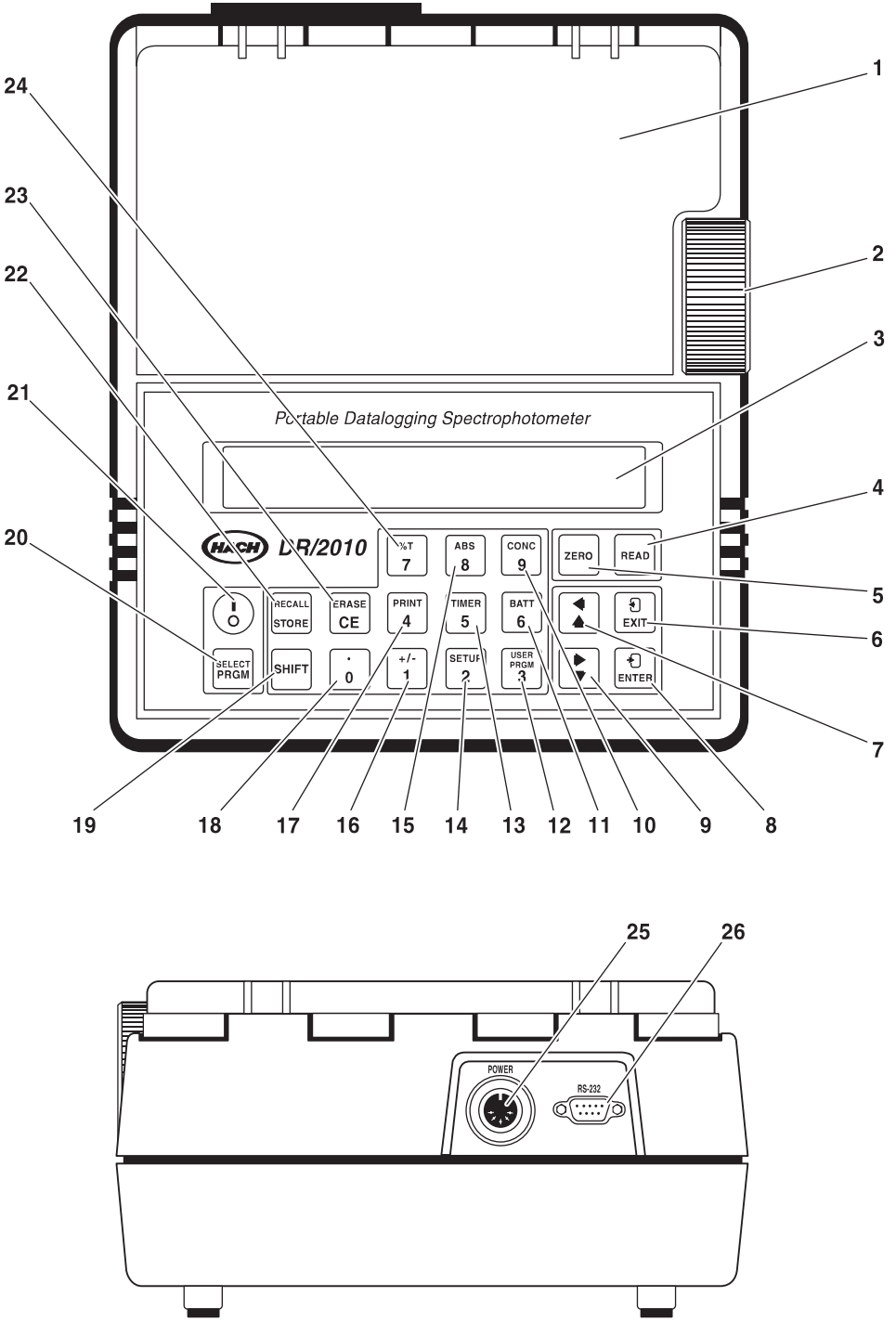


Table 4 Operating Controls, Indicators and Connections

Item No.	Name	Description
1	Cell Compartment Cover	Light shield for sample cell compartment. Contains list of stored program numbers on underside.
2	Wavelength Control	Used to select appropriate wavelength in nanometers for test parameters.
3	Display	LCD window divided into three function areas: wavelength, numeric output and alphanumeric message. Indicates wavelength, prompts and gives measurement results in operational modes. Displays menu options when scrolling through menu with arrow keys. Provides error messages when invalid entries are made.
4	**READ** key	Used to start measurement readings of standards and samples in Momentary mode. Not necessary in Constant-On mode.
5	**ZERO** key	Used to zero the instrument with the blank solution in the cell holder before measuring the sample.
6	**EXIT** key	Each press moves the display up/back one level in the menu without altering memory or settings. Acts as an escape key. Exits current menu or edited item without retaining changes made during the edit.
7	**UP/LEFT ARROW** key	Scrolls through selected menus or programs. Moves cursor to the left (left arrow accessed with **SHIFT** key).
8	**ENTER** key	Used to confirm a prompt or answer “yes” to a displayed question. Accepts the displayed value. The display then returns to the next level up in the menu. Also used to enter a submenu.
9	**DOWN/RIGHT ARROW** key	Scrolls through selected menus or programs. Moves cursor to the right (right arrow accessed with **SHIFT** key).
10	**CONC/9** key	Initiates concentration readout mode when used with **SHIFT** key. Has numeric key function when not used with **SHIFT** key.
11	**BATT/6** key	Used to check condition of battery when used with **SHIFT** key. Current battery voltage and battery-life bar graph will be displayed. Has numeric key function when **SHIFT** key is not used.
12	**USER PRGM/3** key	Used to enter a user-program menu when used with **SHIFT** key. Has numeric function when **SHIFT** key is not used.
13	**TIMER/5** key	Starts timer when used with the **SHIFT** key. Has numeric key function when **SHIFT** key is not used.

Table 4 Operating Controls, Indicators and Connections (Continued)

14	**SETUP/2** key	Used to enter the Startup menu options such as time, date, beeper options, etc., when used with the **SHIFT** key. Has numeric function when **SHIFT** key is not used.
15	**ABS/8** key	Initiates absorbance readout mode when used with **SHIFT** key. Has numeric key function when **SHIFT** key is not used.
16	**+/-/1** key	Used to change the sign of the displayed number when used with the **SHIFT** key. Has numeric function when **SHIFT** key is not used.
17	**PRINT/4** key	Initiates printing sequence to a printer or computer when used with **SHIFT** key. Has numeric key function when **SHIFT** key is not used.
18	**./0** key	Used to enter a decimal when used with **SHIFT** key. Has numeric function when **SHIFT** key is not used.
19	**SHIFT** key	Used to select the top (blue) function of the dual function keys.
20	**SELECT PRGM** key	Selects a menu that allows the user to choose a test by scrolling or by program number (Hach program numbers and symbols are inside the cell compartments light shield).
21	**I/O** key	Toggles operating power on and off.
22	**RECALL/STORE** key	Recalls stored measurement data when used with **SHIFT** key. Used to store measurement data when **SHIFT** key is not used.
23	**ERASE/CE** key	Used to delete stored data when used with the **SHIFT** key. **CE** is used to delete a numeric entry (deletes the whole entry or just the last character).
24	**%T/7** Key	Initiates % Transmittance readout mode when used with **SHIFT** key. Has numeric key function when **SHIFT** key is not used.
25	**POWER** Jack	Connection for AC adapter or battery eliminator/charger.
26	**RS232** Connector	9-pin serial port for printer or computer interface.

3.2 Spectrophotometer Setup and Use of Navigation Keys

A number of instrument operating features are available as options in the **Setup Menu**:

- Group number (assigns a user-specified group number to store data from a set of samples)
- Auto Group (automatically assigns the program number as the group number to store data from a set of samples)

- Lamp operating status (Momentary or Constant On)
- Serial I/O (baud rate, bits, parity)
- Date (day, month, year) and time settings (hours, minutes, seconds)
- Beeper options (for keys, errors and alerts)
- Signal Average
- Language choice (English, French, German, Spanish, Portuguese, or Dutch))
- User-selected automatic shut off time
- Adjust display contrast (8 settings)
- Updates to existing Hach programs or for new Hach programs

When choosing options from menus, the arrow, ENTER and EXIT keys help navigate between menus and within menu options. Pressing the ENTER key enters a new menu or allows changes to the portion of the display that is flashing. ENTER also accepts the changed setting. Pressing the EXIT key leaves a menu or tells the instrument to leave the setting as displayed.

Use the ENTER key to enter a menu. Press ENTER again to change the option that is flashing (**it must flash to change**). Use a NUMERIC or ARROW key to change the option that is flashing. Press ENTER again to accept the new setting. Press EXIT to leave the menu.

ARROW keys move from one menu item to the next or change the selection within a menu.

3.2.1 Using the Setup Menu

You may enter the Setup Menu from the Program Menu, the User Program Menu, Store Menu or Hach Program Menu by pressing SHIFT SETUP. *Table 5* is an overview of the Setup Menu options. A detailed explanation of these items follows.

Table 5 Setup Menu Message Guide

Message	Selections
Auto Group	ON: Instrument assigns stored samples to a group number that is the same as the program number. Default is Off.
Group	Select group number. Default is 0.
Lamp	Momentary or Constant On

Table 5 Setup Menu Message Guide (Continued)

Message	Selections
I/O Options	Submenu: Baud: 9600 is default. Other choices: 4800, 2400, 1200, 600, 300 Bits: Default is 8; other choice is 7 Parity: None is default; Other choices: Even, Odd
Date:xx-Sep-96	Set day-month (alpha)-year (in that order); For example 06-Aug-96
Time: xx:xx:xx	Set hours-minutes-seconds (in that order). For example 23:30:21.
Beeper Options	Submenu: Key Beep: Default is On; Other choice: Off Error Beep: Default is On; Other choice: Off Alert Beep: Default is On; Other choice: Off
Signal Average	Default is Off; Other choice: On
Lang	Default is English; Other choices: Japanese, Dutch, Spanish, Portuguese, French, and German
Adjust Contrast	Arrow keys increase or decrease contrast; 10 choices possible.
Auto Off	Selects number of minutes between last key press and automatic shutoff when in the momentary lamp mode.
Program Update	Use this menu when updating Hach programs or entering new Hach programs.
Adjust nm	Calibrates the optics in the instrument. Peak filter: Lets user determine the peak transmittance using the 808 nm filter. Default Setup: DR/2010 Spectrophotometer will use factory wavelength calibration with no adjustment.
Service Menu	For Hach Service personnel only.

1. Press: **I/O**. Wait for the self-test to finish.

2. Press: **SHIFT SETUP**.

   The first menu option is **Auto Group**. If Auto Group is ON, it will automatically assign stored samples to a group number that is the same as the program number. For example, the data for a reactive phosphorus Test ’N Tube test will be stored in group 535 because the program number in the DR/2010 is #535. Sample numbers may be assigned automatically or by the operator in the Store Menu.

   To change the OFF-ON status of Auto Group, press **ENTER** (otherwise press the **DOWN ARROW**). Use the **ARROW** keys to toggle between Off and On. Press **ENTER** when the desired status is displayed.

   Press the **DOWN ARROW** to advance to the next option (options in step 3 are not shown if Auto Group is ON).

Note: *Using group numbers for storing data points makes recalling the data easier. Group numbers are "subdirectories" for different sets of samples.*

3. The second Setup Menu option is **Group: 0**. A group number may be assigned by the operator. A group number can be used for a set of samples from a specific site, a specific date or samples tested by a specific person.

To assign a group number, press **ENTER**. Use the arrow or numeric keys to enter a group number. Group numbers range from 0 to 999. If you do not choose Auto Group ON or assign a group number, the instrument will assign and store Group 0 to any values that are stored. Press **ENTER** to confirm the group number.

Press the **DOWN ARROW** to scroll to the next option.

Note: *Use the group and sample numbers to identify specific details of the collected data. Analysts can be assigned specific group numbers to satisfy GLP (good laboratory practice).*

4. The next submenu option is **LAMP: Momentary**. To change the lamp status, press **ENTER** (if not, press the down arrow key). Use the **ARROW** keys to toggle between Momentary and Constant On. Select one by pressing **ENTER** when the desired choice is flashing.

Constant On allows you to take readings without pressing the **READ** key each time; the instrument automatically measures the solution in the sample cell. Use Momentary mode when operating on battery power. The lamp is on for a short time only, saving battery power.

Press the **DOWN ARROW** to scroll to the next option.

5. The fourth submenu is **I/O Options**. To change the information in this submenu, press **ENTER** (otherwise press the **DOWN ARROW** key). Use the **ARROW** keys to scroll through Baud Rate, Bits and Parity. To change these settings, press **ENTER** when the word is flashing in the display. Then use the **ARROW** keys to scroll through the choices. Press **ENTER** when the correct choice is flashing. These settings should match the settings of the printer, recorder, computer, etc.

The choices for baud rate are 9600, 4800, 2400, 1200, 600, 300.

The choices for bits are 8 and 7.

The choices for parity are None, Even, and Odd.

Press **EXIT** to return to the Setup Menu.

6. Press the **DOWN ARROW** key to get to the **Date** option. To change the date, press **ENTER**.

Use the NUMBER keys to select the correct day (enter two digits for the date; i.e., 08:Jul:96 = July 8, 1996). The month will automatically flash.

When the month is flashing, use the ARROW keys to scroll to the desired month. Press ENTER to accept the month.

When the year is flashing, use the numeric keys to enter the last two digits of the desired year. Press ENTER to accept the year.

If necessary, press CE to restore the previous date. Press the DOWN ARROW to move to **Time**.

7. The sixth option is **Time**. Press the DOWN ARROW if you do not wish to change the time settings. To change the time, press ENTER. Use the NUMERIC keys to select the correct hour, minute and seconds (in that order). The instrument has a 24-hour time format. The maximum setting is 23:59:59. Enter two digits for each unit of time (i.e., 19:30:25 = 7:30 p.m. plus 25 seconds). Press ENTER when the correct time is displayed.

Press the DOWN ARROW key to move to the next option.

8. The seventh option under **Setup** is **Beeper Options**. Press ENTER to enter this submenu (press the DOWN ARROW to skip it).

The first selection under the **Beeper Options** submenu is **Key Beep**. Press ENTER if you want to change whether the beeper sounds when the keys are pressed. Use the ARROW keys to toggle between off and on. Press ENTER when the desired choice is flashing. Press the DOWN ARROW key to move to the next option.

The second option under **Beeper Options** is **Error Beep**. Press ENTER if you would like to change if the beeper sounds when errors occur (press the DOWN ARROW to skip this). Use the arrow keys to toggle between on and off. Press ENTER when the desired choice is flashing. Press the DOWN ARROW to move to the next option.

The third option under **Beeper Options** is **Alert Beep**. Press ENTER if you would like to change if the beeper sounds when alerts occur (press the DOWN ARROW to skip this). Use the ARROW keys to toggle between on and off. Press ENTER when the desired choice is flashing. Press the DOWN ARROW to move to the next option.

Press EXIT to return to the **Setup Menu**.

The beeper selections are independent of the beeper heard with the timer or low battery signal. They are always active when appropriate conditions occur.

9. **Signal Average** is the eighth option in the Setup Menu. When turned on, this option averages several readings from the sample and displays the average result from the sample (good for use with turbid samples or samples that give unstable readings). When this option is off, the instrument takes only a minimum number of readings to obtain the sample measurement.

   To change the signal average setting, press ENTER (press the DOWN ARROW to skip this). Use the ARROW keys to toggle between on and off. Press ENTER when the desired choice is flashing. Press the DOWN ARROW to scroll to the next option.

10. **Language** is the next option. Press ENTER to change the language used in the display. Use the ARROW keys to scroll through the choices (press the DOWN ARROW to skip this). Press ENTER when the correct language is flashing. Choices include English, French, Spanish, Dutch, Portuguese, and German. Press the DOWN ARROW to scroll to the next option.

11. **Contrast** is the tenth option under Setup. Press ENTER to change the contrast on the display (press the DOWN ARROW to skip this). Use the arrow keys to increase or decrease the contrast. Press ENTER when the contrast is correct. Press the DOWN ARROw key to scroll to the next option.

Note: *Adjusting the contrast may help to read the display under different lighting conditions (i.e., outdoors vs. indoors).*

12. **Auto Off** is the next option. It allows the user to select the amount of time, in minutes, between the last key press and the automatic shutoff. The default is 15 minutes. The maximum time allowed is 99 minutes. Use the ARROW keys to increase or decrease the amount of time desired. Numeric keys may not be used to adjust this time.

13. The next option is **Program Update**. Press ENTER to add a new Hach program or change selected portions of a Hach programmed method following written instructions supplied by Hach (press the DOWN ARROW to skip this). The software upgrade package and a computer may be used to upgrade the software instead of updating the program manually. Follow the instructions from Hach to enter the correct entries. The instrument will also display prompts to guide you.

14. **Adjust nm** is the next option. Press ENTER to re-set the wavelength of the peak absorbance of the optics. This may be necessary if the wavelength calibration goes beyond the specification range.

15. **Service Menu** is the last option. This option is a display check used by Hach Service personnel only.

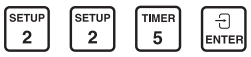
3.3 Testing With Programmed Methods

The DR/2010 Spectrophotometer Procedures Manual provides illustrated, step-by-step procedures for performing all the factory-entered methods. This instrument manual has supplemental information on how the instrument performs the necessary functions, and how to use the special operating features. Once you are familiar with the basic operation of the instrument, the instructions in the procedure manual are sufficient to analyze your samples.

To add your own programs, we recommend placing a copy of the User-Entered Calibration Worksheet into the procedure manual to provide a single-source for all the instrument's test capabilities.

Table 6 illustrates a typical factory-programmed test run in the momentary mode. A more detailed discussion of *Table 6* items follows the table.

Table 6 Typical Hach Procedure

Step	Action/Keystroke	Display
1. Turn power on.		**Self Test V.xx** then **Enter Program #**
2. Select a Stored Program (for example, program 225).		**P 225 Dial nm to 522**
3. Set Wavelength; The wavelength number will flash until the correct setting is chosen.		**P225 Zero Sample** then **P225 mg/L Mg-$CaCO_3$**
4. Insert blank and press **ZERO.**		**Zeroing. . . . .** then **0.00 mg/L Mg-$CaCO_3$**
5. Place the prepared sample into the cell holder. Press **READ**.		**Reading. . . .** then **1.00 mg/L Mg-$CaCO_3$**

Colorimetric testing with preprogrammed calibrations has four general phases: spectrophotometer setup, sample preparation, zeroing the instrument and measuring the prepared sample. In the following paragraphs, the scope of each phase is described in detail.

3.3.1 Spectrophotometric Setup for Hach Programs

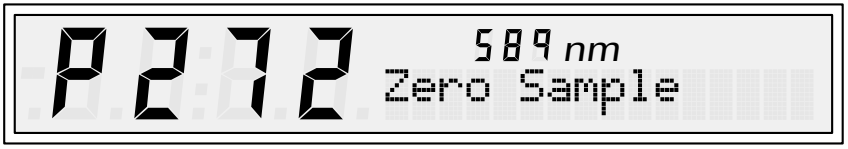
Spectrophotometer setup using a Hach program is limited to selecting the program number, the wavelength and the chemical form (i.e., P, PO_4^{3-}, P_2O_5). Selection of a chemical form is not always an option. The lid label and each procedure will tell you which programs have alternate forms.

Prompting messages will appear in the display at the appropriate times to guide the operator through the procedure. When the instrument is turned on, **SELF-TEST** with the software version number appears.

The first prompt displays:

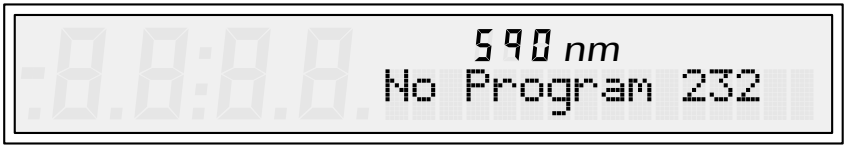
A list of the tests and their program numbers is located on the underside of the sample compartment cover (light shield).

To enter the desired program number, use the **NUMERIC** keys. Press **ENTER**. If the wavelength setting is already correct, the prompt to adjust the wavelength will not appear and the instrument goes to the zero prompt:



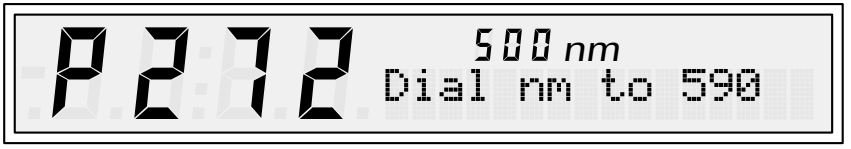
If a different program is desired, enter the program number with the numeric keys or use the arrow keys to scroll to it. Holding an arrow key down allows rapid scrolling. During scrolling, the program number is displayed in the large digits (left side), and the parameter name is displayed in the text area.

If the number selected is not valid, an error signal sounds (if beeper is on) and the display momentarily reads:



The display returns to the prompt for the program number. Re-enter the correct program number. The display will show (for example):

When the proper program is displayed, press **ENTER**. Unless the instrument is already adjusted to the correct wavelength, the instrument prompts for the correct wavelength value; for example:



Adjust the wavelength control until the nanometer (nm) readout matches the prompted value. ***Always approach the desired wavelength from the high side for best accuracy and repeatability.*** When the values are the same, the prompt will change to **Zero Sample**, followed by the program's units and chemical form (see section *3.3.3 Zeroing the Spectrophotometer*).

Note: *If the wavelength is not set properly according to the programmed wavelength, the wavelength number in the display will flash. You may, however, perform the test with an alternate wavelength by pressing the* **ENTER** *key when the alternate value is in the display. The nanometer display will continue to flash, indicating the recommended wavelength is not being used.*

3.3.2 Sample Preparation

The zero solution (or blank) is usually prepared at this time. The blank for a specific procedure can be a variety of solutions:

- Sample being tested without the reagents
- Sample with reagents and a masking agent added
- Deionized water
- Deionized water with reagents added (a reagent blank)

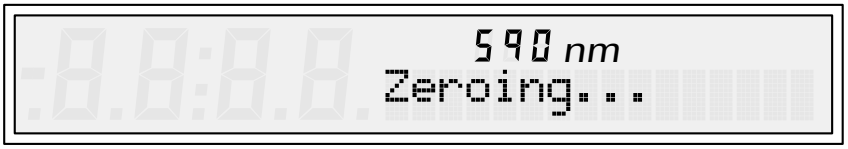
Generally, sample preparation consists of adding the contents of a premeasured reagent pillow(s) to 10 or 25 mL of the sample. Follow the instructions in the Procedures Manual.

It is important to observe the waiting period specified in the particular test procedure to be certain that the color (due to the reaction of the reagent with the substance being measured) develops fully. Many procedures also give a maximum time limit after which the color may begin to fade.

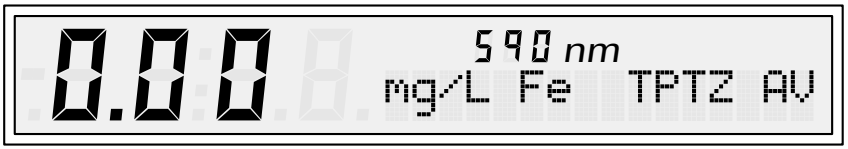
The DR/2010 Spectrophotometer has color development times programmed into the method software. The operator is notified by a series of short beeps when the time has elapsed. The timer must be initiated by pressing **SHIFT TIMER** at the time the countdown should begin.

3.3.3 Zeroing the Spectrophotometer

The instrument must be zeroed for each test or series of tests to establish a zero reference for the measurement. This is done by placing a zero solution (as described in the test procedure) in the cell holder and pressing **ZERO**. The display will show:



and the next prompt will indicate the instrument is ready for the first sample:



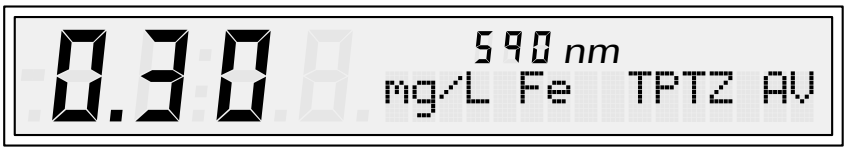
Note: *Once the zero reference point has been established, several samples can be measured consecutively by placing them into the cell holder and closing the light shield. If in the Momentary mode, you must press the* **READ** *key for each measurement. The instrument can be re-zeroed at any time by placing the zero solution (blank) into the instrument and pressing the* **ZERO** *key.*

3.3.4 Measuring Prepared Samples

In the Constant-On mode, just place the prepared sample into the cell compartment (with the 10 or 25-mL mark to the left as shown in *Figure 12*) and close the light shield. The test result is displayed immediately and continuously updated. In the Momentary mode, however, you must press the **READ** key when ready to take the reading; the result is not continuously updated as it is in Constant-On mode.

The display shows:

In about 6 seconds, the test result appears; for example:



The corresponding absorbance or percent transmittance values are displayed simply by pressing **SHIFT ABS** or **SHIFT %T**, respectively. **SHIFT CONC** restores the concentration display.

Note: *Absorbance or percent transmittance measurements can be made without selecting a method. When the program prompt is displayed, press* **SHIFT ABS, SHIFT %,** *or select* **PROGRAM #0**. *After establishing the zero reference point using a blank, absorbance or percent transmittance measurements are displayed.*

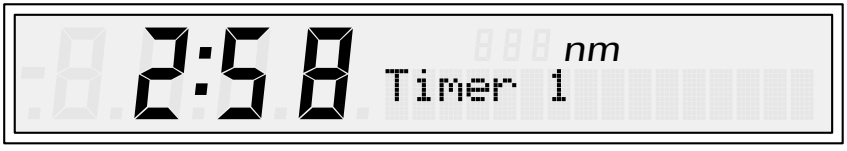
Note: *Clean sample cells help achieve accurate results. Wipe cells free of smudges and finger prints with a soft cloth or paper towel before inserting into the cell compartment.6*

3.3.5 Alternate Chemical Forms

If other chemical forms for the parameter exist in the software, you may use the arrow keys to scroll through these alternate forms after the measurement is displayed. For example, in program #100, mg/L Cr may also be displayed as mg/L CrO_4^{2-} or Na_2CrO_4. If there are alternate forms, a symbol in the procedure manual (see at left) will denote them after the final reading step.

3.4 Timers

For Hach programs, the timer is started by pressing **SHIFT TIMER.**
The display will show (for example):



The timer will automatically start, displaying the remaining time. When the timer is done, three series of four beeps will sound. The display will show: **0:00**

The manual timer is an additional feature that allows the operator to use the timer independently from the method timer. A manual timer is always available, but only one timer may be used at any time. If not currently using a timer, there are two methods to select the timer:

a) Press **SHIFT TIMER.** If the program does not include any stored time intervals, the display shows:

Figure 12 Placing Cells in Cell Holder

If a stored timer is initiated when **SHIFT TIMER** is pressed, press **CE** to clear. Use the arrow keys to scroll to "**TIMER=MM:SS**". Then use the **NUMERIC** keys to enter the desired time. For example, to enter 2 minutes, press **2 0 0**. To enter 12 minutes, press **1 2 0 0**. The display will show the desired time.

To start the time period, press **ENTER**. The display will show the remaining time. At the end of the period, the instrument sounds four beeps.

Using this method to select a timer inserts the timer into the program timer stack (i.e., Timer 1, Timer 2, etc.). The manual timer will not follow the last program timer in sequence. The timer displayed when **EXIT** is pressed will be the next timer to run when **SHIFT TIMER** is pressed again.

However, this timer will not become a permanent part of the program and will not appear the next time the program is used.

b) Enter the time with the **NUMERIC** keys, then press **SHIFT TIMER.** For example, to enter a five-minute period, press **5 0 0 SHIFT TIMER.** Selecting the timer using this method is a "use once" option.

If you are currently using a (displayed) timer, the timer can be reset by pressing **CE.** To switch to a manual timer press the **DOWN ARROW** key until the display shows (MM:SS will be flashing):

Press the desired **NUMERIC** keys to reset the timer. Then re-start the timer (press **ENTER**) or move to the next program timer (press an **ARROW** key).

To switch the display between the time and the concentration display, alternately press **EXIT** and **SHIFT TIMER.**

3.5 Storing Data

Note: *Helpful hint: To organize data from different procedures, use the Auto Group function. Data is automatically stored in a group number the same as the program number. This allows easier recall of the data from specific procedures (for more information, see section 3.2).*

To store sample data, press **STORE** after the sample measurement is displayed. You must store data if you wish to recall it for review, printing or downloading. The following information is stored for each sample:

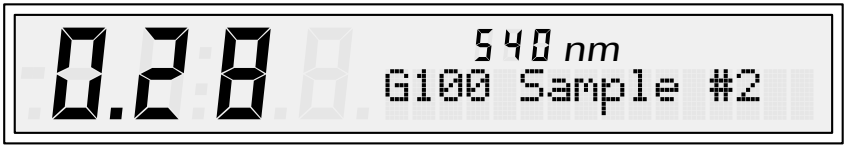
- program number
- concentration
- absorbance
- %T
- sample number
- the wavelength at which the test was read
- Any warning conditions (e.g., incorrect wavelength)
- date
- time
- parameter and units
- group number

1. After pressing **STORE**, the display shows (X is the group number assigned; Y is the next available sample number within that group):

   SAMPLE #Y

   or

   GX SAMPLE #Y



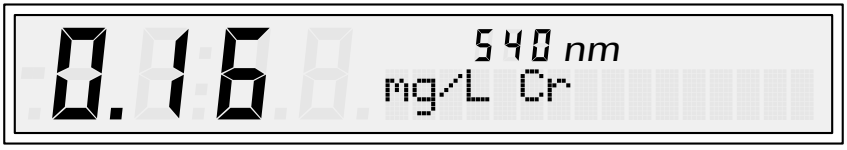
2. Press **ENTER** or **STORE** to accept the sample number. To enter another sample number, use the **ARROW** keys to scroll to the desired number or enter the desired number with the **NUMERIC** keys. Press **ENTER** or **STORE** to accept the desired number. The instrument will store the data, then revert back to the measurement display.

   If the desired storage number is known, enter the number with the **NUMERIC** keys, then press **STORE** (pressing **ENTER** is not necessary).

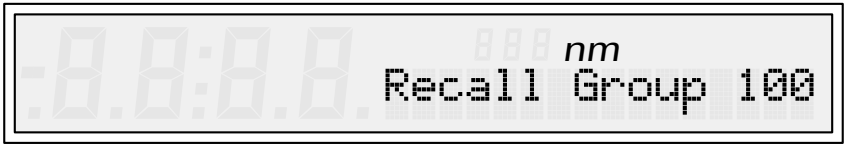
3. To change the group number before storing a displayed data point go to the Setup menu by pressing the **EXIT** key once. Press **SHIFT SETUP** to enter the Setup menu. Use the **ARROW** keys to scroll down to the Group option (Auto Group must be OFF). Press **ENTER**. Enter the correct group number with the **NUMERIC** keys or scroll to it using the **ARROW** keys. Press **ENTER**. Press the **EXIT** key to return to the Store menu.

3.6 Recalling Data

1. To recall data stored in the DR/2010 Spectrophotometer, press **SHIFT RECALL**. If the data is stored only in Group 0, the display will show data for the last sample of the last program used (for example):



If the data is stored in more than one group, the display will show (for example):

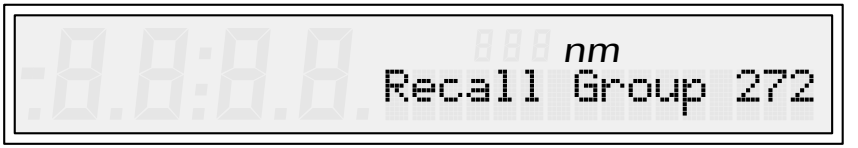


2. Enter the desired group number by scrolling to it with the **ARROW** keys or by entering the group number with the numeric keys. Press **ENTER**.

The wavelength displayed in **Recall** is the wavelength at which the sample was measured, not the current position of the monochromator.

3. To recall other data within the selected group, use the **ARROW** keys to scroll through the samples in the group.

4. To recall samples stored in other groups, press **EXIT**. The display will show the next group number of stored data (in increasing order). For example, after reviewing data in Group 1, the display might show:



Press **EXIT** until the instrument returns to the measure mode.

3.7 Printing Data

Printed data will include the following information:

- instrument model and serial number
- concentration, absorbance or %T (whichever is displayed)
- date
- time
- group number (for stored data only)
- sample number (for stored data only)
- the wavelength at which the test was read
- warning conditions in effect at the time of measurement

3.7.1 Printing Current Measurement Data

To print data that is displayed after a measurement, press **SHIFT PRINT**. The display will show **PRINTING . . . . .** and then return to the normal measurement display. The printed information is sent in an 80-column format (see *Figure 13*).

Figure 13
Printed Data Format Example

25-JUN-96	13:45:23	*1.245 mg/L An. Surfact	575nm	DR/2010	P710	SN:789456123
25-JUN-96	14:03:11	-0.05 Abs 300.2 %T	575nm	DR/2010	P710	SN:789456123
26-JUN-96	07:12:46	7.95 mg/L NO_2^- HR	*593nm	DR/2010	P373	SN:789456123

*Denotes that a warning occurred during reading or the wavelength used was not the wavelength in the program

3.7.2 Printing Stored Data

To print stored data, you must display the data, then print it. To display the data, use the Recall menu (see *3.6, Recalling Data).*

3.7.2.1 Printing Single Stored Data Points

When the data for the desired group and sample number are displayed, press **SHIFT PRINT**. The display will show (i.e., G100 is the group number assigned; #3 is the sample number):

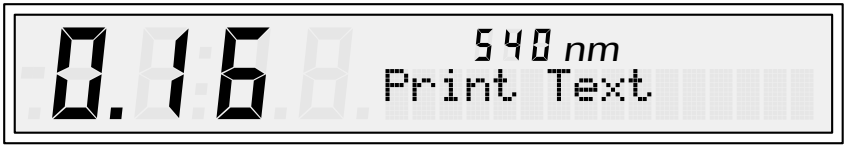
Press **ENTER**. The display will show **PRINTING. . . . .** and then return to the units and parameter.

If the data is stored only in Group 0, the display will only show the sample number. The rest of the printing sequence is the same.

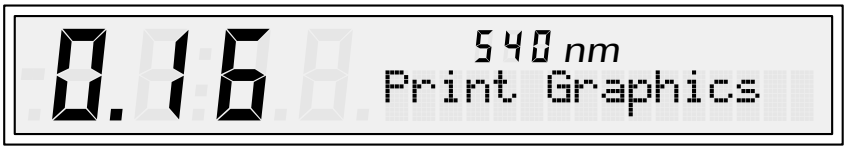
3.7.2.2 Printing All Data Stored in One Group

1. To print all the data in one group, press **SHIFT PRINT** after the group and sample number is displayed. Then press the **DOWN ARROW**. The display will show:

2. Press **ENTER**. The display will prompt:



3. To print the data in the group as text, press **ENTER**. A printout like the example in *Figure 14* will occur. To print the data in the group as a graph, press an **ARROW** key. The display will show:



4. Press **ENTER**. If your printer supports graphics, the data will plot a graph with the X axis as sample number (in increasing order) and the Y axis as the concentration. This data is useful for monitoring trends in the sample stream.

Figure 14
Sample of Printed Data Within a Group

DR/2010 Stored Data Report SN:789456123 Printed 25-JUN-96 15:15:22

Sample	Group	Concentration		Program/Wavelength	Date Stored	
312	8	*-0.051	mg/L An. Surfact	P710 575nm	26-JUN-96	13:45:21
314	8	1.032	mg/L An. Surfact	P710 575nm	26-JUN-96	14:56:23
444	8	0.104	mg/L An. surfact	P710 570nm *	26-JUN-96	15:01:33
510	8	0.820	mg/L An. Surfact	P710 575nm	28-JUN-96	08:20:35
521	8	0.554	mg/L An. Surfact	P710 575nm	19-JUN-96	10:05:16

*Denotes that a warning occurred during reading or the wavelength used was not the wavelength in the program

3.7.2.3 Printing All Stored Data

1. To print the stored data in all the groups, press **SHIFT PRINT** after the group/sample numbers are displayed. Then press the **DOWN ARROW** twice. The display will show:

2. Press **ENTER**. A printout like the example in *Figure 15* will occur.

Figure 15
Sample of Printed Data in Multiple Groups

DR/2010 Stored Data Report SN:789456123 Printed 14-JUN-96 15:15:22

Sample	Group	Concentration	Program	Wavelength	Date Stored	
312	8	-0.051 mg/L An. Surfact	710	575nm	06-JUN-96	13:45:21
314	8	1.032 mg/L An. Surfact	710	575nm	06-JUN-96	14:56:23
444	8	0.104 mg/L An. Surfact	710	575nm	06-JUN-96	15:01:33
510	8	0.820 mg/L An. Surfact	710	575nm	08-JUN-96	08:20:35
521	8	0.554 mg/L An. Surfact	710	575nm	11-JUN-96	10:05:16
3	4	0.08 mg/L Cl	80	530nm	25-MAY-96	09:44:43
4	4	0.10 mg/L Cl	80	530nm	26-MAY-96	11:09:23
5	4	0.09 mg/L Cl	80	530nm	27-MAY-96	10:03:51
6	4	0.08 mg/L Cl	80	530nm	28-MAY-96	10:33:54
1	3	1.31 mg/L Cl	80	530nm	01-JUN-96	08:22:46
2	3	1.26 mg/L Cl	80	530nm	02-JUN-96	09:33:11
3	3	1.37 mg/L Cl	80	530nm	03-JUN-96	10:02:25
4	3	1.28 mg/L Cl	80	530nm	05-JUN-96	09:46:17
5	3	1.33 mg/L Cl	80	530nm	06-JUN-96	08:38:24
6	3	1.27 mg/L Cl	80	530nm	07-JUN-96	09:56:01

3.7.3 Printing Setup Menus

If it is necessary to record setup parameters (i.e., Automatic Group, Group 0, ...) press **SHIFT PRINT** while you are in the **Setup** menu. The display will show **PRINTING. . . . .** and return to the **Setup** menu. *Figure 16* shows the printout for the **Setup** menu.

Figure 16
Sample of Setup Menu Printout

DR/2010 Setups Report SN:789456123 Printed 22-SEP-96 22:10:43

Auto Group: OFF Group: 169
Lamp Mode: Momentary
Input/Output Options: Baud Rate: 1200
Parity: None
Bits: 8

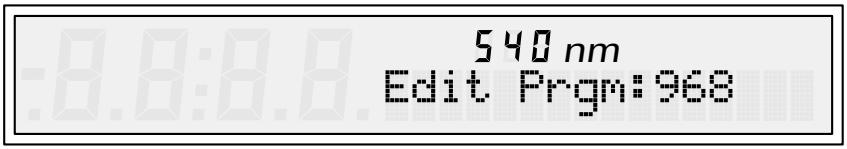
Beeper Options: Key Beep: ON
Alert Beep: ON
Error Beep: ON

Signal Average: ON
Language: English
Contrast: 8
Auto Shutoff Time: 5 minutes

3.7.4 Printing User Programs

To have a written copy of a user program for reference, the program must be completed and stored first (see section *3.9 Storing User Programs*).

1. Press **SHIFT USER PRGM.** Scroll to the **Edit Program** option. Press **ENTER.** The display will show (For example):



2. Select the desired user program number (scroll or use **NUMERIC** keys).
3. Press **ENTER.** The display will show the program name.
4. Press **SHIFT PRINT.** The display will show (for example):

   To print the calibration table and other information about the program press **ENTER.** To print the calibration table, the calibration curve and the other information about the program, press the **DOWN ARROW.** Printing the calibration curve is highly suggested, especially for quadratic and cubic fits. A visual review is better than comparing r^2 correlation coefficients. The display will show (for example)

5. Press **ENTER.**
6. The display will show **PRINTING . . . .** and return to the program name. *Figure 17* shows the text printout for a user program.

The equations and coefficients in the software are of the form: Conc = f(Abs). That is, concentration is a function of absorbance. The graphs, however, are plotted using the inverse relationship. Absorbance is on the y-axis and concentration is on the x-axis, implying an Abs = f(Conc) relationship.

Figure 17
Example Of A User Program Printout

DR/2010 User Program Report SN:789456123
Printed 26-MAR-96 11:32:55
Adj Chloride Test - Program Number: 968 Last Calibrated: 23-JAN-96 09:21:00
Default Measurement Form: 00.00 mg/L Cl
Alternate Form 2: 0.000 mg/L NaCl Factor: 0.1420
Alternate Form 3: 0.000 mg/L EDL Factor: 1.000
High Limit: 8.97 mg/L Cl
Low Limit: 0.05 mg/L Cl
Monochromator Wavelength: 420 nm

Standard	Concentration	Absorbance
1	0.05 mg/L Cl	0.007
2	0.20 mg/L Cl	0.028
3	0.50 mg/L Cl	0.070
4	1.00 mg/L Cl	0.140
5	2.00 mg/L Cl	0.281
6	5.00 mg/L Cl	0.700
7	10.00 mg/L Cl	1.400

Calibration Curve Forced Through Zero? Yes
Calibration Style: $C = a + bA + cA^2 + dA^3$
a = 0.000
b = 0.1050
c = 0.0052
d = - 0.0002
r^2 = 0.9994
Timer 1: 3:30 Timer 2: 5:00

3.8 Erasing Data

You may only erase stored data after it is recalled using the **RECALL** key. To recall data, see *3.6, Recalling Data.* Erasing stored data may take up to 35 seconds. The instrument will not display an "in progress" message. Please leave the instrument on during the process.

3.8.1 Erasing Single Data Points

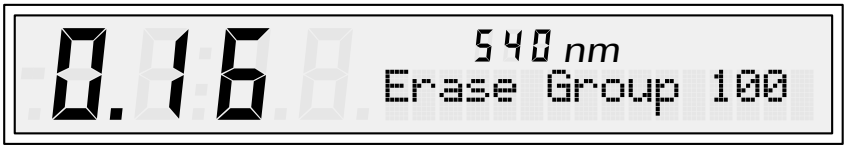
1. When the desired group and sample number are displayed, press **SHIFT** **ERASE**. The display will show (i.e., G100 is the group number assigned; #3 is the sample number):

2. Press **ENTER**. The display will show **ERASED** and then return to the displayed group and sample number.

If the sample is stored in Group 0, the display will only show the sample number. The rest of the erase sequence is the same.

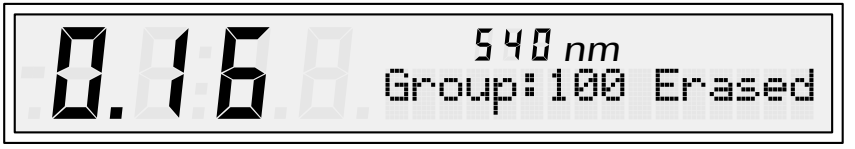
3.8.2 Erasing All Stored Data in One Group

1. To erase all the data in one group, press the **DOWN ARROW** after the group/sample number is displayed. The display will show:



2. Press **ENTER.** The display will prompt:

3. Press **ENTER** if you still want to erase the data in that group. The display will show (for example):

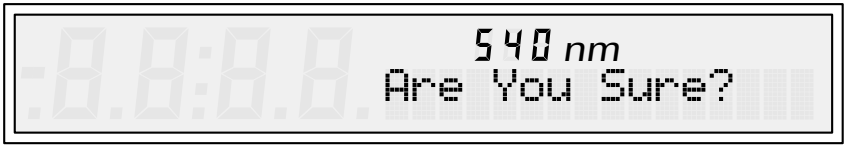


Press **EXIT** to leave the erase menu without erasing any data.

3.8.3 Erasing All Stored Data

1. To erase the stored data in all the groups, press **SHIFT ERASE**, then press the **DOWN ARROW** twice after the group and sample number are displayed. The display will show:

2. Press **ENTER.** The display will prompt:



3. Press ENTER if you still want to erase all the data stored in all groups. Press EXIT to leave the erase menu without erasing any data.

3.9 Storing User Programs

The DR/2010 Spectrophotometer stores 50 User Programs (#950-#999). If you try to store additional methods, the instrument will beep and display:

****NO PRGM SPACE****

Programs 950 through 999 are reserved for storing user-entered programs. In the standard technique, absorbance values of a series of standards are measured and stored in memory and the concentration values are entered via the keyboard.

If the absorbance and concentration values already are known, the absorbance and concentration values may be entered via the keypad. No standard solutions are needed.

If the type of curve and the coefficients are known, you may enter the curve directly by entering the coefficients.

The maximum number of data points that can be entered for a method is 45.

Note: *The Constant On mode is recommended when creating a user-entered method. In Momentary mode, the instrument turns off automatically if no key is pressed for the user-selected time period (in Setup Menu) resulting in the loss of any data points or edits entered.*

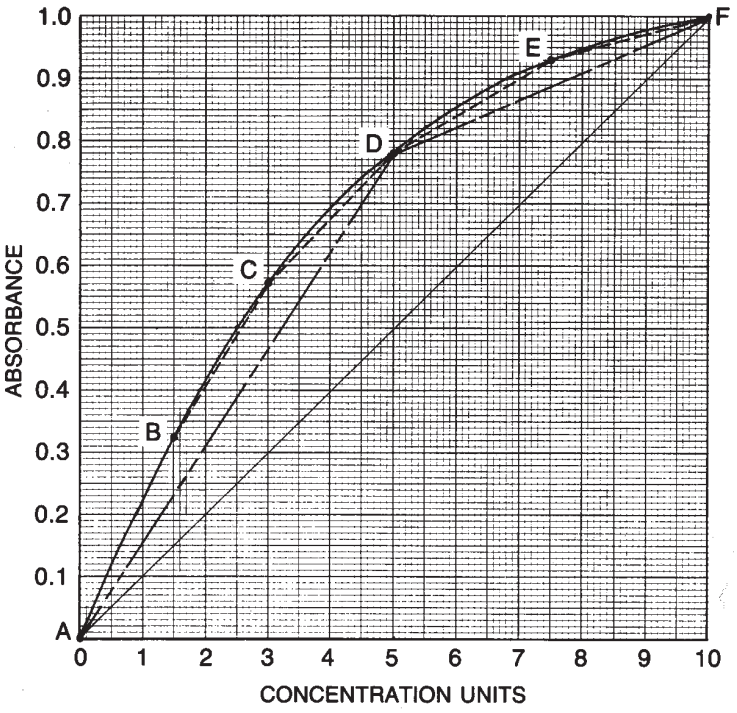
Before entering a calibration, determine the optimum wavelength, timing sequences (if any) and workable range of the program. Use the Sample User-Entered Calibration Worksheet in the back of this manual to create a user-entered method and provide documentation for future reference.

Calibration curves may have positive or negative slopes, but they must be based on absorbance (% transmittance not allowed). The user has the option to force the curve through 0,0 (origin) as part of the calibration.

It is important that the standards adequately describe the curve over the range of interest. Because calibration curves may not necessarily be a straight line, it may be necessary to prepare a preliminary curve using many data points (standards). You may print this calibration curve for review using the optional Citizen PN60 printer (see section *3.7.4*).

If the curve is linear, only two concentration data points are needed. For example, a standard with a zero absorbance and a standard with 1.000 absorbance are appropriate. If the curve is nonlinear, additional data points are needed to achieve good accuracy. Up to 45 data points can be entered for a single calibration curve. *Figure 18* illustrates why additional data points are necessary to adequately describe nonlinear curves.

Figure 18
Calibration Curve



If only points A and F are entered, the instrument bases its calculation on a straight line (A-F), and the result is grossly in error. By adding the data point D, the curve is greatly improved with the two straight lines A-D and D-F, but in some regions of the curve, measurements still may not be accurate enough. Further improvement is gained when data points B, C and E are entered, giving straight lines A-B, B-C, C-D, D-E and E-F.

Table 7 briefly describes the Create Program menu. In-depth instructions of the menu selections follow the table.

Table 7 Create Program Submenu Selections

Display	Selection/Action
New Prgm:	Enter a program number between 950 and 999.
Program Name:	Enter name using **ARROW** keys and/or **NUMERIC** keys (16 character maximum).
Decimal:	Use **ARROW** keys to move decimal to correct place.
Units:	Use **ARROW** keys to scroll through choices. Custom units that are not included in the option list may be entered as part of the Symbol (16 character maximum). Leave the Units option at "none".
Symbol:	Enter the chemical form (i.e., PO_4^{3-}) as a character string using arrow keys and numeric keys. Custom units may also be entered as part of the chemical symbol. (16 character maximum).
Alternate Form2: **(Alternate Form3:)** **(Alternate Form4:)**	Submenu: Decimal2- move decimal to correct position. Press **ENTER**. Press **DOWN ARROW**. Units2- scroll to correct units. Press **ENTER**. Press **DOWN ARROW**. Symbol2- Enter an alternate chemical form (i.e., P_2O_5 or P) using **ARROW** and **NUMERIC** keys. Factor2- enter factor number using the **NUMERIC** keys.
Low Limit: 0.00	Enter the low limit of the measurement range with **NUMERIC** keys.
High Limit: 9.99	Enter the high limit of the measurement range with **NUMERIC** keys.
Wavelength: 0nm	Enter the desired wavelength with the **NUMERIC** keys. Press **ENTER**. Press the **DOWN ARROW**.
Calib. Table: 0	Submenu: Zero Sample- put blank in and press **ZERO**. Dial nm to X- Dial to correct wavelength. Enter concentrations of each standard as prompted.
Zero: Off	Default is Off. To force the calibration through 0,0 point, use **ARROW** key to toggle to On.
Calib Formula: F0	Submenu: F0: C=Piecewise (a line from data point to data point). Press **ENTER** to choose a different type of equation (C = Concentration, A = Absorbance; a, b, c = coefficients): F1: $C = a + bA$ F2: $C = a + bA + cA^2$ F3: $C = a + bA + cA^2 + dA^3$
Timer1: Not Set **(Timer2):** **(Timer3):**	Enter minutes and seconds.
Store Program	Press **ENTER** to store program.

3.10 Creating A User Program

At any point during the following procedure, the operator can terminate entering the calibration, and exit by pressing **EXIT**. The display will show:

Press **ENTER** to store the program. Press **EXIT** to exit without storing the entered data.

1. Turn the instrument on with the **I/O** key.
After the self-test the display will show:

2. Select the Lamp: Constant On mode in the Setup menu. Return to the Enter Program prompt by pressing **EXIT**.

3. Press **SHIFT USER PRGM** to go to the Create Program menu.
The display will show:

4. Press **ENTER.** The display will show:

5. Press **ENTER.** The program number will flash. The instrument automatically displays the next available program. If the number displayed by the instrument is desired, press **ENTER.** You may also enter the desired program number between 951 and 999 number using the **NUMERIC** keys.

6. Press **ENTER**. The display will show:

(The number 952 is used as an example here; the actual program number displayed is the lowest, unassigned number between 950 and 999 available at the time).

Press **ENTER**. Then press the **DOWN ARROW** key.
The display will prompt for the program name (16 character maximum):

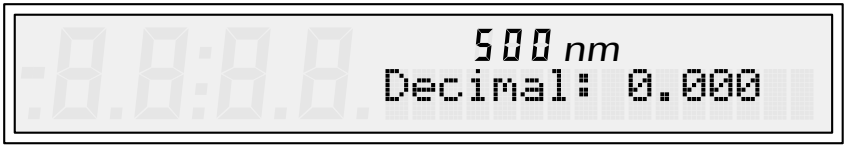
There are two techniques for constructing the name:

a) Selecting characters by entering appropriate numeric codes with the keypad (see "Constructing a Display Using Numeric Codes" on page 65). Press **ENTER** after each character is selected.

b) Scrolling through the character menu with the arrow keys. Press **SHIFT** twice to capitalize letters, subscript or superscript numbers. Press **ENTER** after desired character is displayed. When the cursor is flashing, press **ENTER** again to accept the character string (see "Constructing a Display By Scrolling on page 67).

To enter a program name press **ENTER**. The display will be blank except for a cursor. Enter the characters using the instructions given in "Constructing a Display Using Numeric Codes" on page 65 or "Constructing a Display By Scrolling" on page 67. When the complete name is entered, press **ENTER**.

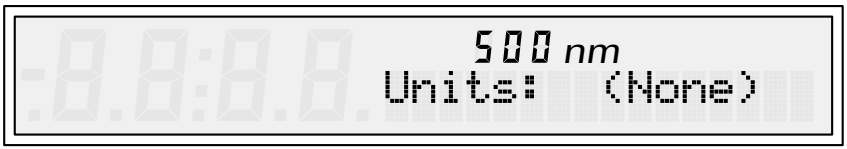
7. Press the **DOWN ARROW** to go to the next option. The display will show:



The flashing Decimal prompt is asking for the appropriate measurement resolution for this test.

8. Press **ENTER** so the decimal point flashes. Set the decimal point position using the arrow keys. Press **ENTER.** The Decimal prompt will flash again. Press the **DOWN ARROW** key to go to the next selection.

9. The display gives the next prompt:

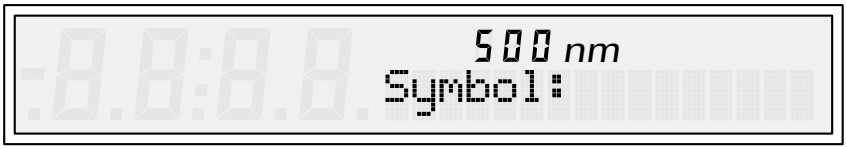


10. To change the units, press **ENTER** so that (None) is flashing. Use the **ARROW** keys to select one of the available units of measure. The menu includes: **mg/L, µg/L, ng/L, ppm, ppb, ppt, g/kg, mg/kg, oz/gal, lb/ac, kg/ha,%, g/gal, mg/100g, mg%, units, ftu, mol/L, mmol/L,** and **meq/L.**

Note: *The first display in the units menu is blank (NONE). If the desired unit is not included above, selection of the blank reserves all sixteen character spaces for input at the next (SYMBOL) prompt; a custom unit can then be constructed along with the symbol describing the method.*

11. When the appropriate units selection appears, press **ENTER.**

12. Press the **DOWN ARROW** to go to the next selection.
The display then prompts:



13. Press **ENTER.** The display will show the selected units followed by a flashing cursor. In the remaining spaces after the semicolon, add various characters to construct a chemical symbol or otherwise describe the method.

There are two techniques for constructing the symbol:

a) Selecting characters by entering appropriate numeric codes with the keypad (see "Constructing a Display Using Numeric Codes" on page 65). Press **ENTER** after each character is selected.

b) Scrolling through the character menu with the **ARROW** keys (see "Constructing a Display By Scrolling" on page 67). Press **SHIFT** twice to capitalize letters, subscript or superscript numbers. Press **ENTER** after the desired character is displayed. Press **ENTER** again to accept the character string. Continue to Step 14 on page 68.

Constructing a Display Using Numeric Codes

The specific numeric code for each character is listed in *Table 8*. Simply key in the appropriate numeric code number (see below) and press **ENTER.** The maximum number of characters that can be entered is 16.

To replace a displayed character entered by mistake, press **CE** and key in the correct number. To accept the character, press **ENTER.** The cursor advances to the next position.

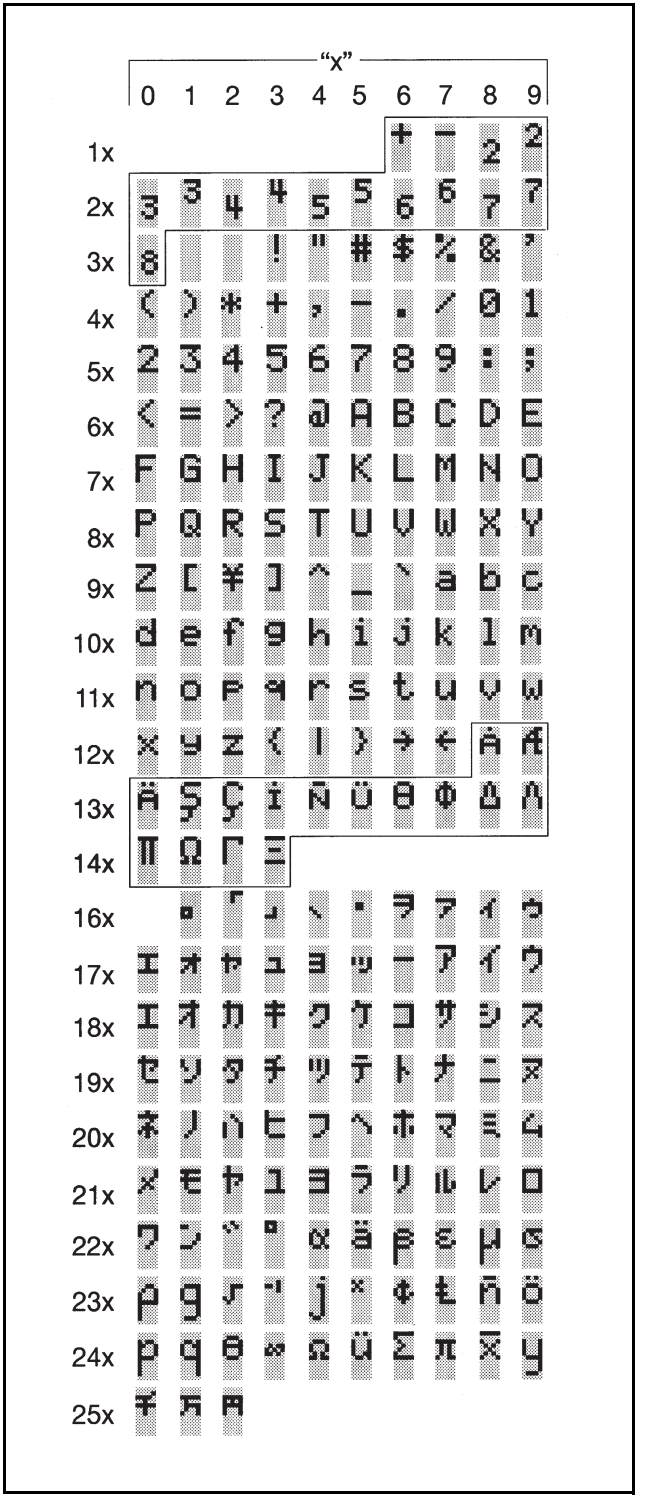
Characters that are accepted can be edited by pressing **SHIFT LEFT ARROW** to back space; then new characters can be entered in their place. After the last character is accepted, press **ENTER** once more to accept the character string. Numeric codes are especially convenient if the display is long or complicated. Considerable time is saved by eliminating scrolling.

How to select characters by code numbers:

In the left column, the "x" represents the second or third digit of the code number and is supplied by the column number in which the desired character is found. For example, if you wanted to select a lower case "k", you would use the first two digits from the row in which the "k" is found, 10, and then use the number of the column, 7, as the third digit of the code number. Thus, keying in 107 with the numeric keys will cause "k" to appear in the display where the cursor is flashing. To accept it as correct, press **ENTER** again. The "k" will be accepted and the cursor will move to the next position, ready to receive the next character code.

The characters in the areas that are boxed are limited in number to four that can be selected in any one message. They can be repeated, but only four different characters can be used.

Table 8 Numeric Code vs. Character



Constructing a Display By Scrolling

To construct a new symbol by *scrolling* use the **ARROW** keys to select characters stored as menu entries in the instrument. By holding down either **ARROW** key, you can scroll through the menu rapidly until you are close to the character being sought, and then proceed slowly until the desired character is displayed. The maximum number of characters that may be entered is 16.

To select the displayed character, press **ENTER**. The cursor advances to the next position. Continue this procedure to complete the symbol. After the last character is selected, press the **ENTER** key a second time to accept the character string and advance to the next prompt. A list of the characters available in the order of their position in the menu is given below.

_ abcdefghijklmnopqrstuvwxyz

To capitalize letters, press **SHIFT** twice.

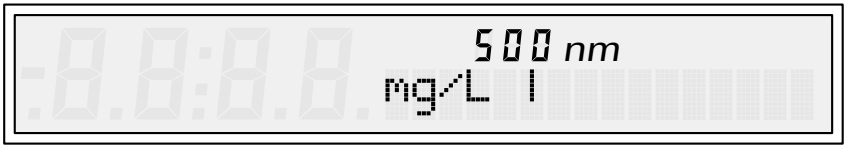
Following z, a series of symbols and numbers appear.

{ } ’ ( ) . / : ; = ? # 0 1 2 3 4 5 6 7 8 9 - + (blank) _

During scrolling, these characters appear full size. Those that can be used for subscript and superscript characters are converted by pressing the shift key twice for subscript and four times for superscript. Subscripts are available for numbers 2 through 8, and superscripts are available for numbers 2 through 6, "-" and "+".

Scrolling Example:

When you press **ENTER** at the **Symbol:** prompt, the display shows the unit of measure followed by the cursor (positioned at the first available position). If mg/L is selected as the unit of measure, the display shows:



Resume scrolling with the arrow keys until the first character is in the display. For example, to construct a display for low-range sulfate (SO_4^{2-} LR), scroll until the letter “s” appears.

The letter is lower case and must be changed to an upper case by pressing **SHIFT** twice. Accept the upper case S with the **ENTER** key, and the cursor advances to the next space.

Scroll to the letter “o”, capitalize the letter with the **SHIFT** key and accept it with the **ENTER** key.

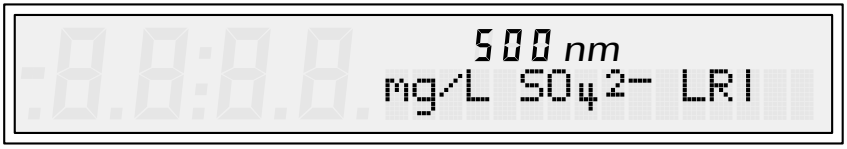
Scroll to the 4 and change it to a subscript by pressing the **SHIFT** key twice. Press the **ENTER** key to accept.

Scroll to 2, change it to a superscript by pressing the **SHIFT** key four times; then press **ENTER**.

Scroll to the minus sign, and press the **SHIFT** key twice to make it a superscript.

To distinguish this low-range sulfate program from the sulfate method already in memory, add **LR** at the end of the symbol field in the display. Scroll to the blank space character (the blank appears between underline and the letter "a"). Accept it with the **ENTER** key. You can enter up to four blank spaces and then enter **L** and **R**.

The display shows (for example):



14. After examining the display to verify that everything is correct, press **ENTER** to accept and store the entire display. **Symbol** will flash. Press the **DOWN ARROW**.

The display will show

15. If desired, press **ENTER** to store an alternate chemical form using the instructions in this section as a guide. The instrument will ask for a **Factor** after you enter Symbol2. Multiplying the displayed reading by the factor gives the result in an alternate chemical form. For example, mg/L nitrate-nitrogen (NO_3^--N) is multiplied by 4.4 to express the result as mg/L nitrate (NO_3). Use the numeric keypad to enter a factor.

16. Press **ENTER** when the correct factor is displayed. Press **EXIT** when all the information for Alternate Form2 is entered.

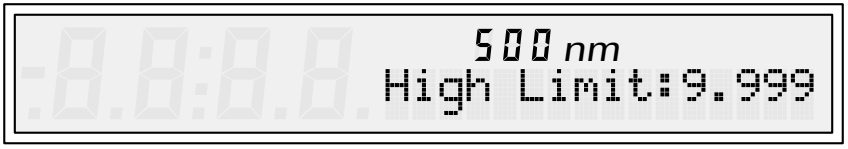
17. Press the **DOWN ARROW.** If any information was entered for Alternate Form2, the display will show:

Enter an Alternate Form3 if desired or press the **DOWN ARROW.** The display will show:

Note: *The low limit reminds stored program users when displayed values are below the working range of the test.*

18. To change the low limit of the procedure range, press **ENTER** (if not, press the **DOWN ARROW**). Use the **NUMERIC** keys to enter the low range limit. Press **ENTER** to accept the displayed number.

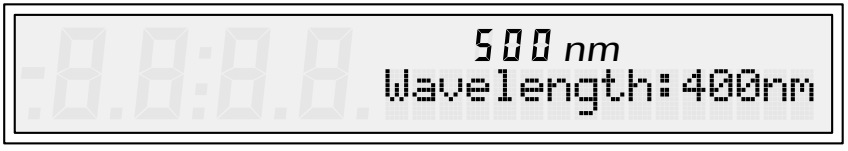
19. Press the **DOWN ARROW** key. The display will show:



Note: *The high limit reminds stored program users when displayed values are above the working range of the test.*

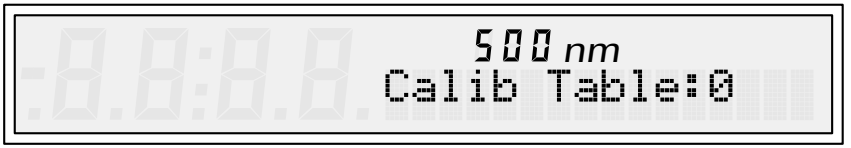
20. To change the high limit of the procedure range, press **ENTER** (if not, press the **DOWN ARROW**). Use the numeric keys to enter the desired high range limit. Press **ENTER** to accept the displayed number.

21. Press the **DOWN ARROW.** The display will show:



22. Press **ENTER.** Enter the desired wavelength using the **NUMERIC** keys. The wavelength must be between 400 to 900 nm. Press **ENTER** when the desired wavelength is displayed.

23. Press the **DOWN ARROW**. The display will show:



At this point, the user has three options to "teach" the instrument how to convert absorbance to the appropriate concentration:

a) Enter Concentration and Measure Absorbance

Note: With option a the instrument should be zeroed with the solution that will be used to zero the instrument when actually running the stored user program.

Create a calibration table by entering concentration values for the standards, then measuring the absorbance of the standards. Enter calibration points one at a time. First enter the concentration using the **NUMERIC** keys, then read the absorbance of the developed standard.

The instrument uses a piecewise linear curve as the default, but will fit the data to all four types of curves (the analyst chooses the best curve), or a calibration curve can be selected from the printed graph of the data points. To enter a calibration curve using this option, press **ENTER** at the **Calib Table: 0** display. Follow Steps 24-44, below.

b) Enter Concentration and Absorbance

Note: It is not important what is used to zero the instrument when entering points for options b and c. In fact, the cell compartment may be left empty.

If calibration data has already been collected by other means, create a calibration table by entering concentration values for the standards, then entering the absorbance values of the standards. The instrument uses a piecewise linear curve as the default, but will fit the data to all four types of curves (analyst chooses the best curve), or a calibration curve can be selected from the printed graph of the data points. To enter a calibration curve using this option, press **ENTER** at the **Calib Table: 0** display. Follow Steps 24-44, below.

c) Direct Coefficient Entry

If you can determine the mathematical relationship (calibration curve) between absorbance and concentration using other software (i.e., Excel, Tablecurve...), enter the coefficients for the type of equation (below) you choose to use.

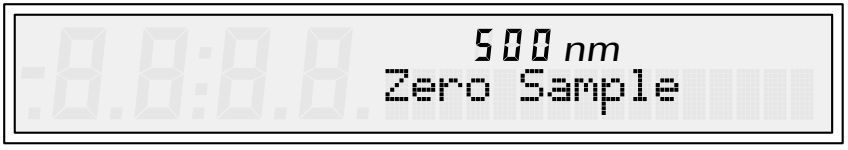
Four types of mathematical relationships between absorbance and concentration exist:

- Piecewise Linear: C = Piecewise
- Linear: C = a + bA (requires ≥ 2 data points)
- Quadratic: C = a + bA + cA^2 (requires ≥ 3 data points)
- Cubic: C = a + bA + cA^2 + dA^3 (requires ≥ 4 data points)

Where: a, b, c, and d are coefficients,
A = Absorbance and C = Concentration.

Three types of equations (linear, quadratic, or cubic) can be used by entering values for the coefficients into the formulas that describe these curves. To enter a calibration curve using the cubic equation option, press the **DOWN ARROW** key twice at the **Calib Table: 0** display. Press **ENTER** at the Calib Formula: F3 display. Proceed with Step 36. The instrument will prompt for the coefficients.

24. Press **ENTER**. The display will show:

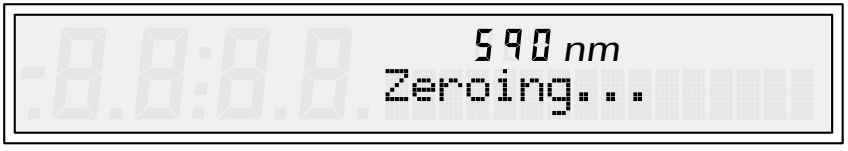


The appropriate timing intervals in the procedure must be used when preparing the zero concentration and calibration standards.

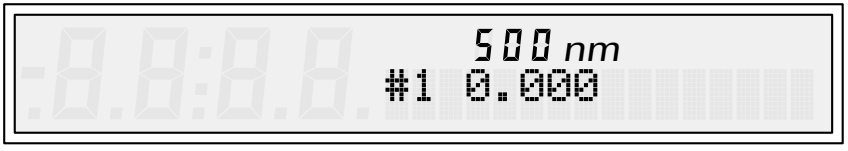
Note: *Follow the procedure steps for reagent addition and color development to make the standards and blank before using them for calibration.*

25. Place a sample cell containing the blank or zeroing solution in the cell holder, close the cover and press **ZERO**. If the wavelength is not correct, the display will prompt you to dial in the correct wavelength. Adjust the wavelength and press **ZERO** again.

26. The instrument displays:

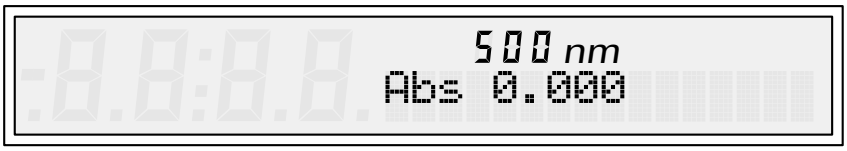


then:



The actual units and decimal place displayed depend on the selections made earlier.

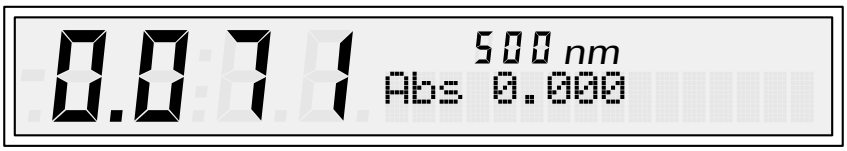
27. The **0.00** will be flashing. Using the **NUMERIC** keys, enter the concentration of the first and lowest standard. Press **ENTER** to accept the displayed number. The display will show (for example):



If units, for example “mg/L”, were entered previously, they will appear in the far right of the display.

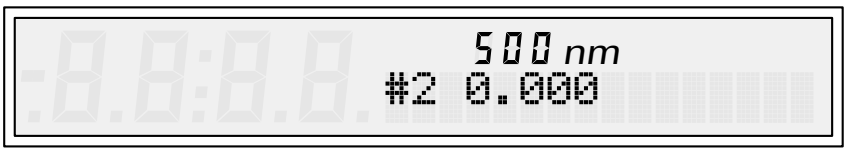
28. Insert the first (lowest concentration) standard in the cell holder and close the cover. Press the **READ** key and the display changes to (for example):

then (for example):



If the absorbance value of the standard is known, enter this value using the numeric key pad. The value will be displayed in the left side of the display in large numbers.

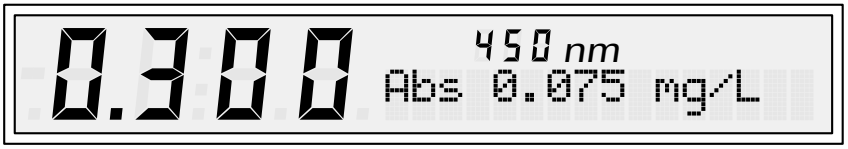
29. Press **ENTER** to accept the displayed absorbance value.
Press **ENTER** to accept the **abs/conc** data pair and bring up the next standard. The display will show (for example):



30. The **0.000** will be flashing. Using the numeric keys, enter the concentration of the second standard. Press **ENTER** to accept the displayed number. The display will show the concentration value.

31. Insert the second standard in the cell holder and close the cover. Press the **READ** key and the display changes to:

then:



If the absorbance value of the standard is known, enter this value using the numeric key pad. The value will be displayed on the left side of the display. Press **ENTER** to accept the absorbance value. Press **ENTER** again to accept the data pair.

32. Repeat the sequence in Steps 30-31 for each standard.

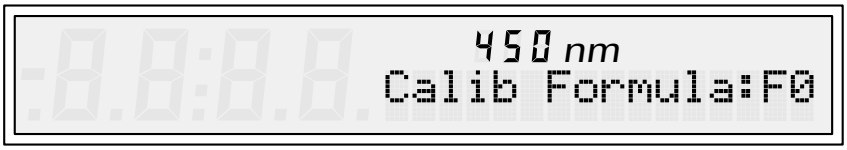
33. After the last standard is entered, press **EXIT** to return to the User Program setup menu. **Calib Table: X** will be flashing (X= number of data points in the calibration table). Press the **DOWN ARROW** key.

34. The display will show:

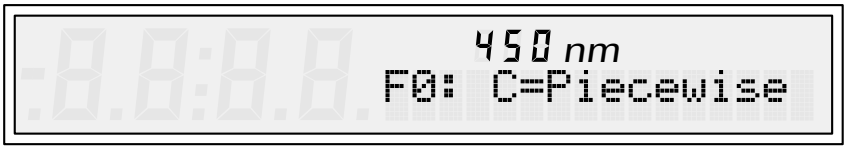
To change this option to On, press **ENTER**. Use the **ARROW** keys to toggle between Off and On. Press **ENTER** when the correct setting is displayed.

When on, this selection forces the calibration curve through the 0, 0 point on the calibration curve graph. If Force Zero is not used, and the intercept ("a" coefficient) is significantly different from zero, pressing **ZERO** will not make the display read 0.00. Zeroing sets the Abs to 0; the displayed concentration depends on the curve itself (i.e., C = -2 + (500 x Abs); zeroing gives -2 as a display).

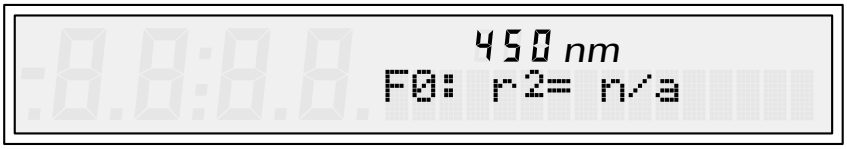
35. Press the **DOWN ARROW** key. The display will show:



36. Press **ENTER.** The display will show:



37. Press **ENTER.** The display will show:



F0 means Formula 0, which is a point-to-point (piecewise) calibration curve. A best-fit line is not possible when using this type of curve, so a correlation coefficient (r^2) is not applicable (n/a). See *Figure 18, Calibration Curve*.

38. Press the **DOWN ARROW.** The display may show (for example):

F1: r^2 = 0.99530 or **F2: r^2 = 0.99322** or **F3: r^2 = 0.99212**

F1 denotes linear equation. F2 means a quadratic equation and F3 denotes a cubic equation. To view the r^2 value of the alternative equations, press the **UP ARROW** key.

Important Note: *Selection of the best calibration curve should not be based solely on the r^2 value. While a quadratic or cubic may have a r^2 value closer to 1.000, it may not be an appropriate fit for the data. There is no substitute for printing out or manually graphing the calibration curve and visually inspecting it to see how it fits the data.*

39. Press **ENTER** to accept the type of calibration curve.
The display will show (for example):

To view the coefficient values, scroll down with the **DOWN ARROW** key. If the calibration table has no points in it, you may press **ENTER** and edit the coefficients. Press **EXIT** to continue with the calibration.

40. Press the **DOWN ARROW** key. The display will show:

41. To enter a timer, press **ENTER**. The display will show:

42. Use the **NUMERIC** keys to enter the minutes and seconds desired. For example, to enter 3 minutes and 30 seconds, press **3 3 0**.
The display will show:

43. Press **ENTER** to accept the time. If an error is made when entering the time, press **CE** to erase the last numeric entry and re-enter the number. Press the **DOWN ARROW**. The display will show:

44. If desired, repeat steps 41-43 to enter up to four timed periods. Press **ENTER** to accept each timer. After the last timer is accepted, press the **DOWN ARROW.**

If a timer is not needed, press the **DOWN ARROW.** The next prompt is:

To store the program, press ENTER. The display will automatically return to the Create Program display. If you do not wish to store the program, press EXIT. If corrections are needed, see section *3.11 Editing User-Entered Programs*.

If only one calibration standard is measured, a straight line between that point and the origin (0 Abs, 0 Conc) is calculated, and measurements are linearly interpolated along that line.

If two or more data points (up to a maximum of 45) are entered, you can choose a piecewise or linear equation for converting absorbance to concentration.

If four or more data points are entered, you can use a piecewise, linear or quadratic equation for converting absorbance to concentration.

If five or more data points are entered, you may use a cubic equation or any of the other equations mentioned to convert absorbance to concentration.

To use a user-stored program, either scroll to the program or enter the program number with the keypad. Any timing intervals stored in the program must be observed when testing samples with the method.

If the concentration of a sample exceeds the high limit, the display flashes a warning of the over-range condition. Repeat the method using a fresh sample that is diluted to fall within range of the calibration curve.

If the concentration of the sample is less than the low limit, the display flashes a warning of the under-range condition.

3.11 Editing User-Entered Programs

All program option information stored previously by the operator can be reviewed and changed to add, delete or modify data points. At any point during the editing function, the operator can terminate the procedure and exit by pressing EXIT. The display will prompt **Store Changes?** Press ENTER to store the changes and exit. Press EXIT to exit without storing changes.

If desired, you may modify only the calibration table for new lots of reagents or changes in the sample matrix (improves accuracy). All the other options of the calibration can remain the same. If you are not sure of making changes to a user program, copy the original program (see section *3.13*). If the changes are not desired the original program is still intact and may be used.

Select a user-entered program for review or modification as follows:

1. Turn the instrument on with the **I/O** key. After the self-test the display is:

2. If the instrument is in Momentary mode, select the Constant On mode in the Setup menu (**SHIFT SETUP**). Return to the **Enter Program** prompt by pressing **EXIT**.

3. Press **SHIFT USER PRGM** to go to the **Create Program** menu. The display will show:

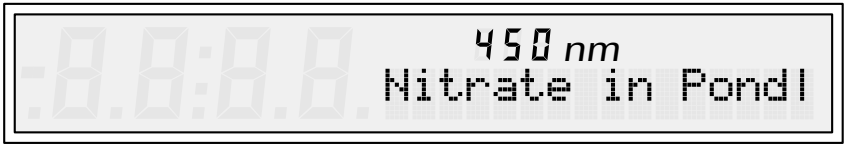
4. Press the **DOWN ARROW** once. The display will show:

5. Press **ENTER**. The display reads:

6. Press **ENTER** if the program number displayed is the program you want to change. If not scroll to the program using the **ARROW** keys or enter the program number using the numeric keys.

7. When the correct program number is display, press **ENTER**. The display will show:

To change the program name, press **ENTER** (if not, press the **DOWN ARROW**). The display will show (for example):



8. The cursor will be flashing. Use the **SHIFT LEFT ARROW** to scroll to the left in the Program Name. The letters will be erased as you scroll left. New characters are inserted in the space to the left of the cursor. Press **ENTER** to accept the new characters. The **SHIFT LEFT ARROW** will then be necessary to bring the cursor back to enter any additional characters.

When finished, press **ENTER** to accept the entire name.

Editing the Symbol is the same as editing the Program Name.

The rest of the **Edit Program** menu is like the **Create Program** menu. Please refer to section *3.10 Creating A User Program*.

It may take up to 35 seconds for the instrument to store the changes made to the user program. Please leave the instrument on during this period.

3.12 Erasing User-Entered Programs

1. Turn the instrument on with the **I/O** key. After the self-test the display will show:

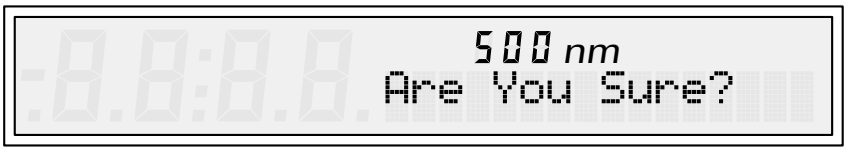
2. Press **SHIFT USER PRGM** to go to the **Create Program** menu. The display will show:

3. Press the **DOWN ARROW** twice. The display will show:

4. To delete the program, press **ENTER** (if not, press **EXIT**). The display will show:

5. If the number displayed is the appropriate program number, press **ENTER**. If not, use the arrow keys to scroll through the other User-entered program numbers, or enter the appropriate number using the **NUMERIC** keys. Press **ENTER** when the appropriate number is displayed.

6. The display will show:



7. Press **ENTER** to erase the program. The display will show:

and return to the **Delete Program Menu.**

3.13 Copying a User-Entered Program

The Copy Program submenu allows users to copy user-entered methods or templates for methods that require a user calibration. When you copy a program or template, all the setup selections, timer information and calibration data is copied.

Factory-stored templates have numbers between 900 and 949. The calibration data in the templates may be nonsensical numbers and need to be replaced with actual calibration data. For other templates, the calibration data will yield semi-accurate results, but should be replaced for more accurate results.

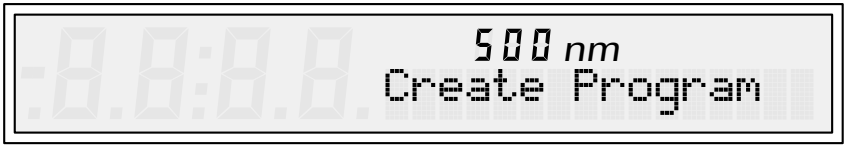
Programs that have a template for copying are arsenic, barium, autocatalytic copper, potassium, TKN and sulfate.

Only user-entered programs and templates may be copied. Hach programs may not be copied.

After the program is copied, enter the calibration data into the program by using one of the methods described in *3.10 Creating A User Program*, starting at Step 23.

1. Turn the instrument on with the **I/O** key. After the self-test the display will show:

2. Press **SHIFT USER PRGM** to go to the **Create Program** menu. The display will show:

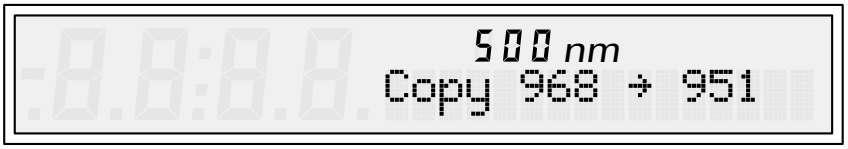


3. Press the **DOWN ARROW** three times. The display will show:

4. To copy the program, press **ENTER** (if not, press **EXIT**). The display will show (for example):

5. If the flashing program number is not correct, enter the correct number with the **NUMERIC** keys or scroll through the available list of user-entered programs using the **ARROW** keys. Then press **ENTER** when the correct number appears (this is the source program).

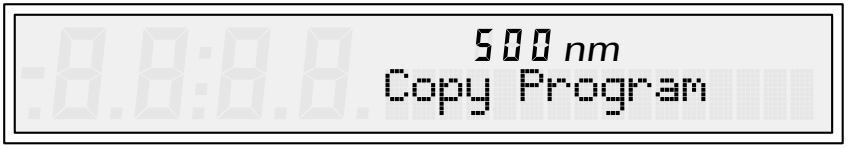
The display will show (for example):



6. The instrument displays the next available user-entered program number on the right side of the display (flashing). To copy the source program as the displayed number (951 in this case), press **ENTER**. To copy the program to another program number, use the **NUMERIC** keys to enter the desired number, or scroll to the desired number using the **ARROW** keys. Then press **ENTER**. Record the chosen number for future reference.

7. The display will show:

then:



Go to section *3.10 Creating A User Program*, step 23, for instruction on entering data into the calibration table.

INSTALLATION/MAINTENANCE

Some of the following manual sections contain danger and cautionary statements and require special attention.

Read and follow all danger and cautionary instructions carefully to avoid personal injury and damage to the instrument. Only qualified personnel should conduct maintenance procedures on this instrument.

Algunas de las secciones de este manual con tienen frases de peligro y advertencias y requiren especial atención.

Leer y seguir todas las instrucciones de peligro o de advertencia cuidadosamente para evitar daños personales y averias al instrumento. Sólo un personal cualificado puede efectuar las operaciones de mantenimiento de este instrumento.

Algumas das seguintes secções manuals contêm indicações de perigo e de cautela e requerem atenção especial.

Leia e siga atentamente todas as instruções de cautela para evitar ferimentos pessoais e não danificar o instrumento. A manutenção deste instrumento só deve ser efectuada por pessoal qualificado.

Certains des chapitres suivants du mode d'emploi contiennent des informations de danger et de prudence et nécessitent une attention particulière.

Lire et observer attentivement toutes les instructions de danger ou de prudence pour éviter les risques de blessures pour le personnel et de dommages pour l'appareil. Les procédures de maintenance sur cet appareil doivent seulement être effectuées par du personnel qualifié.

Einige der folgenden Abschnitte dieser Betriebsanleitung enthalten Hinweise auf Gefahren und Vorsichtsmassnahmen aufmerksam gelesen und befolgt werden.

Wartungsarbeiten an diesam Gerät dürfen nur von qualifiziertem Personal durchgeführt werden.

SECTION 4 INSTALLATION

4.1 Battery Installation

The battery compartment is accessible from the underside of the instrument. Make sure the sample cell holder is empty. Lay the instrument upside down on a padded surface, and install batteries as follows:

1. Disconnect all external connections to the instrument (RS232, battery eliminator, power cord...). Remove the compartment door as shown in *Figure 19 Battery Installation*.

2. Install six alkaline D-cells in the battery holder as shown in *Figure 19*. Do **not** use nickel-cadmium batteries in this instrument. The voltage is too low for proper operation.

CAUTION
Lead-acid batteries contain sulfuric acid that could be released if the battery case ruptured. If sulfuric acid contacts the skin, immediately flush the contacted area with water for 15 minutes. Remove contaminated clothing.

CUIDADO
Las pilas de plomo-ácido contienen ácido sulfúrico, que puede derramarse al romperse el revestimiento de la pila. Si el ácido sulfúrico hace contacto con la piel, enjuague inmediatamente con agua el área expuesta durante 15 minutos. Quítese la ropa contaminada.

PRECAUÇÃO
As baterias de chumbo-ácido contêm ácido sulfúrico que pode ser liberado se quebrar a caixa da bateria. Caso o ácido sulfúrico entre em contato com a pele, lave-se imediatamente a parte do corpo que fez contato com água durante 15 minutos. A pessoa deverá tirar a roupa contaminada.

ATTENTION
Les batteries au plomb-acide contiennent de l'acide sulfurique qui peut s'écouler en cas de rupture du corps de la batterie. Si l'acide sulfurique atteint la peau, laver immédiatement la partie atteinte à l'eau pendant 15 minutes. Retirer les vêtements contaminés.

WARNHINWEIS
Bleibatterien enthalten Schwefelsäure, die im Falle einer Batteriegehäusebeschädigung lecken kann. Wenn Schwefelsäure mit der Haut in Berührung kommt, muß die verschmutzte Hautfläche sofort für 15 Minuten mit Wasser gewaschen werden. Die kontaminierte Kleidung muß entfernt werden.

DANGER
Use of nickel-cadmium batteries under a fault condition creates a potential fire hazard.

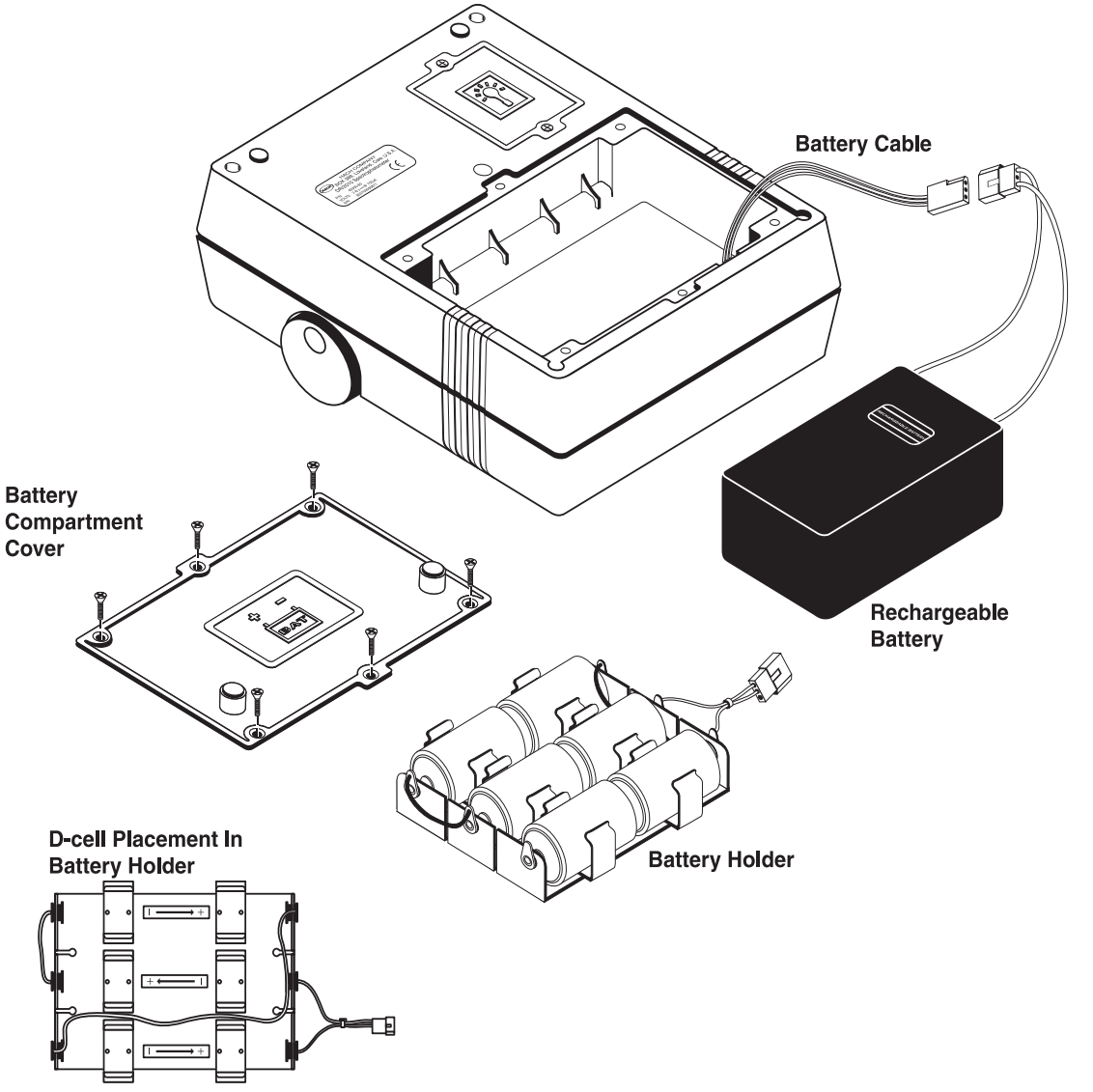
PELIGRO
La utilización de pilas de níquel-cadmio en condiciones de falla crea el riesgo de incendio.

PERIGRO
O uso de baterias de níquel-cádmio em condição de falha cria a possibilidade de incêndio.

DANGER
L'utilisation de batteries nickel-cadmium dans des conditions inappropriées crée un risque d'incendie.

GEFAHR
Unter einer Störungsbedingung stellt die Verwendung von Nickel-Kadmium-Batterien eine Feuergefahr dar.

Figure 19 Battery Installation



CAUTION
Use care when installing the D-cells in the battery holder to be sure that the proper polarities are observed. Improper installation could cause damage to the instrument or injury to the operator.

CUIDADO
Tenga cuidado que los polos estén debidamente orientados al instalar las pilas D en el estuche para pilas. Instalación inadecuada puede dañar el instrumento o lesionar al operario.

PRECAUÇÃO
Tenha cuidado ao instalar as pilhas tipo D no porta-baterias para ter certeza que se observam as polaridades corretas. A instalação incorreta pode causar estragos ao instrumento e lesão grave ou danos ao equipamento.

ATTENTION
Prendre soin de respecter les polarités à l'installation des piles taille D dans le support de piles. Une erreur d'installation peut endommager l'appareil et blesser l'opérateur.

WARNHINWEIS
Während der Installation der D-Zellen im Batteriehalter muß sichergestellt werden, daß die richtige Polarität eingehalten wird. Eine falsche Installation kann das Instrument beschädigen und den Bediener verletzen.

DANGER
For both safety and performance reasons, never remove the battery cover from this product except when servicing the battery.

PELIGRO
Para mayor seguridad y funcionamiento no quite la tapa de bateria de este aparato excepto cuando necesita mantener la bateria.

PERIGO
Por razões de segurança e funcionamento, nunca retire a tampa do compartimento das baterias, excepto para proceder à sua substituição.

DANGER
Pour des raisons de sécurité et de performances, ne jamais retirer le capot du compartiment de pile de cet appareil sauf pour des interventions sur la pile.

GEFAHR
Für störungsfreien und sicheren Betrieb sollte die Batterieabdeckung nur zum Wechseln der Batterien entfernt werden. Die Abdeckung ist zuerst immer wieder einzusetzen, bevor Sie mit der Arbeit beginnen.

3. *Attaching the D-Cell Battery Holder*: Connect the battery cable from the instrument to the battery holder cable connector.

4. *Optional Rechargeable Battery*: If using a rechargeable battery (instead of D-cells), place the rechargeable battery into the battery compartment, and connect the battery cable from the instrument to the rechargeable battery cable connector. Be sure to have the "Carefree" label on the battery facing you during installation. This will minimize leakage should it occur.

5. Replace the battery compartment cover, and return the instrument to the upright position.

6. If the rechargeable lead-acid battery is used, charge the battery for 18 to 20 hours to achieve optimum charge. Charging is recommended before extensive use, but the battery is usable when received.

4.2 RS232 Connection

Note: *For optimum performance and protection against ESD, use a three conductor shielded cable. Use a metal shell for the printer or CRT terminal connector, and connect the shield of the cable to the metal shell and to the sleeve (signal ground) of the RS232 plug.*

The RS232 receptacle on the back panel of the DR/2010 Spectrophotometer connects with a 9-pin Sub-D connector as indicated in *Figure 20*. A suitable RS232 cable is listed under Optional Accessories in *REPLACEMENT PARTS*.

The RS232 interface default output is an eight-bit data word plus one stop bit and no parity with a baud rate of up to 9600 (see section *3.1* for other options). It can communicate with either a serial printer or a serial communication port on a computer.

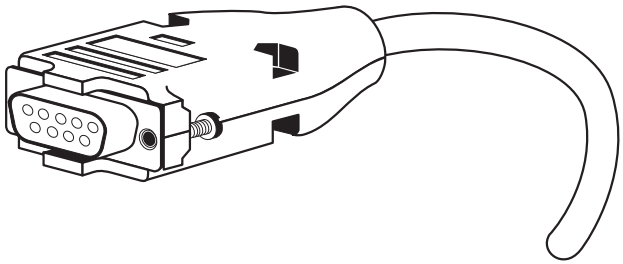
With the use of a serial-to-parallel converter, the data string transmitted from the DR/2010 Spectrophotometer prints on any compatible parallel printer of the type normally used with IBM compatible applications.

If desired, construct a shielded replacement cable using *Table 9*:

Table 9 Standard 9-pin to 9-pin Computer Cable

DR/2010 9-pin D Connector Socket		Computer 9-pin D Connector, plug	
Pin	**Signal Name**	**Pin**	**Signal Name**
2	RXD	3	TXD
3	TXD	2	RXD
4	DTR	no connection	
5	GND	5	GND
6	DSR	no connection	
7	RTS	8	CTS
8	CTS	7	RTS

Figure 20 RS232 Connection



4.2.1 Additional Interface Information

Depending on the interface application, it may be necessary to know the following communication characteristics:

- The DR/2010 Spectrophotometer sends one stop bit.
- A carriage return and line feed character are sent at the end of each line.
- The DR/2010 Spectrophotometer uses hardware handshaking.

SECTION 5 MAINTENANCE

5.1 Cleaning

5.1.1 Spectrophotometer

Keep the spectrophotometer and sample cells clean at all times. Wipe up spills promptly. Use a lens tissue or a soft, lint-free cloth (that will not leave an oil film) to wipe the photocell window located on the left-hand side of the cell holder.

5.1.2 Sample Cells

Clean sample cells with detergent, rinse several times with tap water, and then rinse thoroughly with demineralized water. Some cells may require acid washing or other special cleaning procedures (see each procedure). Rinse sample cells used with organic solvents (chloroform, benzene, toluene, etc.) with acetone before the detergent wash, and again as a final rinse before drying. Polystyrene disposable sample cells are available (refer to *REPLACEMENT PARTS).*

5.1.3 Pour-Thru Sample Cell

Remove the Pour-Thru cell occasionally to check for accumulation of film on the windows. If the windows appear dirty or hazy, soak in a detergent bath and then rinse thoroughly with demineralized water. Do not use solvents (e.g., acetone) to clean the Pour-Thru cell. The Pour-Thru cell can be disassembled for cleaning if necessary.

CAUTION
Do not use the Pour-Thru Cell in tests that call for the use of organic solvents such as toluene, chloroform, trichloroethane or cyclohexanone. These solvents may not be compatible with the plastic components of the Pour-Thru Cell creating the potential for equipment damage and chemical exposure for the analyst.

ADVERTENCIA
No utilice la Célula de Flujo Continuo para pruebas que requieran el uso deo solventies orgánicos tales como tolueno, cloroformo, tircloretano o ciclohexanona. Es posible que estos solventes sean incompatibles con los componenetes de material plástico de la Célula de Flujo Continuo y existe el riesgo de daños al equipo y exposición del analista a las substancias químicas.

AVISO
Não use a Pilha de Vazamento em testes que exigem o uso de dissolventes orgánicos como tolueno, cloroformo, tricloroetano e ciclohexanona. Existe a possibilidade que estes dissolventes não dejam compatíveis com os componentes de plástico da Pilha de Vazamento, o que pode criar a possibilidade de estrago ao equipamento e exposição química para o analista.

ATTENTION
Ne pas utiliser la cuve à circulation dans les techniques d'analyses qui utilisent des solvants organiques tels que le toluène, le chloroforme, le trichloroéthane ou la cyclohexanone. Les solvants organiques peuvent ne pas être compatibles avec les composants en plastique de la cuve à circulation et endommager l'équipement en créant un risque chimique pour l'opérateur.

WARNHINWEIS
Die "Pour-Thru-Zelle" darf nicht in Tests verwendet werden, die organische Lösungsmittel wie Toluol, Chloroform, Trichlorethan oder Cyclohexanon erfordern. Die Möglichkeit besteht, daß diese Lösungsmittel nicht mit den Kunstoffkomponenten der "Pour-Thru-Zelle" kompatibel sind und somit Geräteschaden verursachen und eine Chemikaliengefahr für den Untersuchungschemiker darstellen können.

5.2 Replacement Instructions

To prevent static electricity damage to the instrument, always turn the instrument off and disconnect all the cables (RS232 and power) from the instrument before removing the battery and lamp covers.

5.2.1 Battery Replacement

When a **LOW BATTERY** message appears in the display, replace the alkaline, D-cell batteries (or recharge the battery if using the optional rechargeable, lead-acid battery). Make sure that the instrument is turned off and all power to the instrument is disconnected. If D-size alkaline cells are used, replace all six batteries (refer to section *4.1 Battery Installation*). If a rechargeable battery is installed, recharge as soon as possible.

5.2.2 Lamp Replacement

If the lamp fails and must be replaced, proceed as follows.

1. Disconnect the Battery Eliminator and the RS 232 connector. Turn off the power switch and empty the cell holder. Place the instrument upside down on a padded surface.

2. Remove the two screws securing the lamp compartment cover and remove the cover (see *Figure 21, Lamp Replacement*).

3. Remove the lamp retainer screw and metal sleeve from the lamp channel. The sleeve is tapered at the bottom end, and, because of its snug fit, probably needs to be loosened with a tool (needle-nose pliers recommended) for removal. Remove the lamp. Loosen the two terminal screws to free the lamp leads.

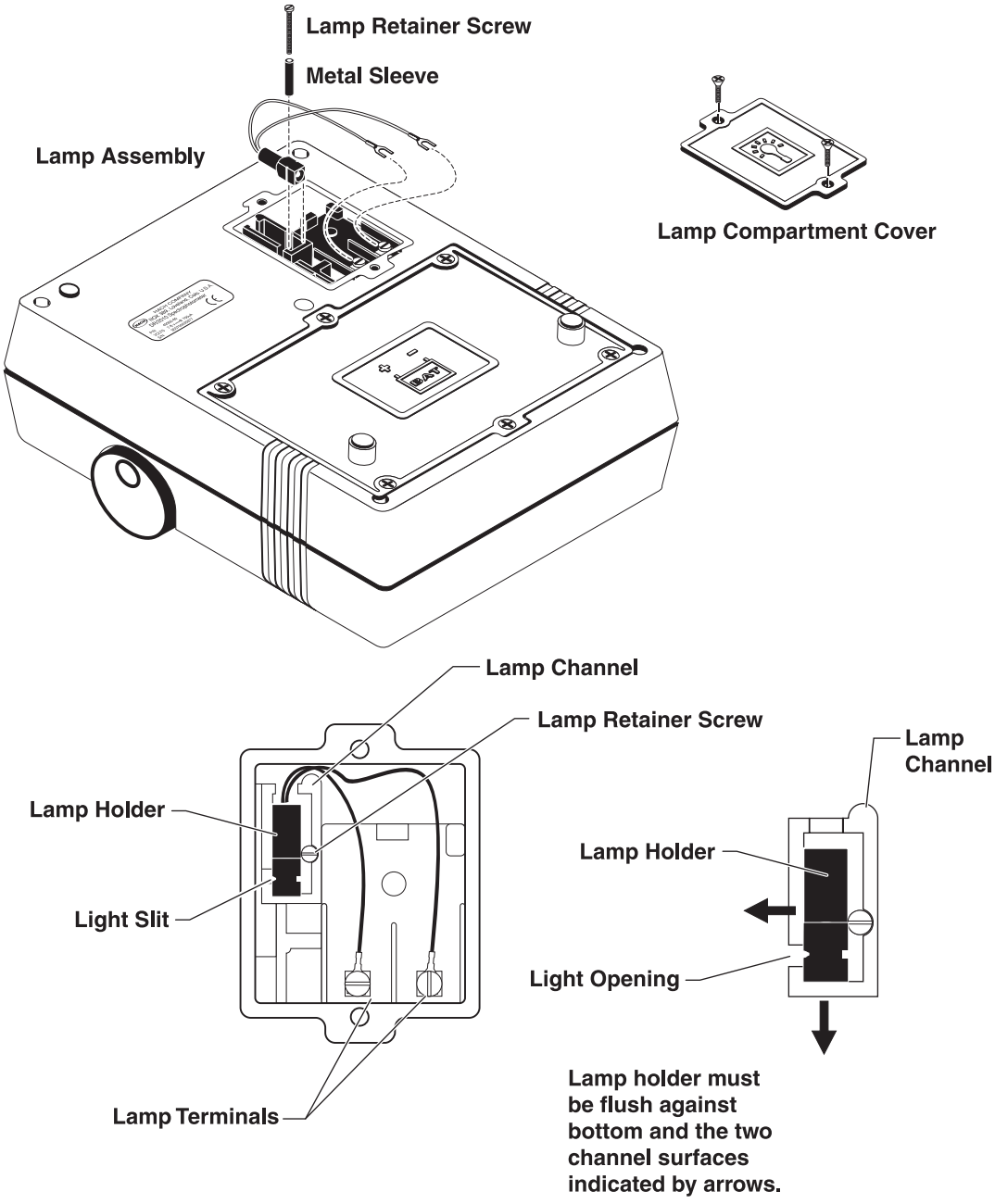
4. Place the new lamp in the lamp channel with the V-shaped lamp light slit toward the light slit in the lamp channel. The square-shaped slot should face the side with the wavelength dial. Push the lamp to the bottom of the lamp channel and install. Firmly tighten the lamp retainer screw and sleeve in the channel to secure the lamp. Secure the sleeve with the beveled end down. The lamp must be held tightly in the proper position, flush against the bottom, the end, and the light slit side of the lamp channel (see *Figure 21*). Connect the lamp leads of the new lamp assembly at the lamp terminals (lead orientation does not matter). Do not overtighten.

5. Install the lamp compartment cover. Return the instrument to the upright position and restore power.

Note: *Some internal components are sensitive to static and may be damaged by external static electricity. Always re-install the lamp cover after maintenance or servicing.*

6. Perform the Lamp Calibration Adjustment procedure described in section *5.3 Lamp Calibration Adjustment.*

Figure 21 Lamp Replacement



5.3 Lamp Calibration Adjustment

1. Empty the cell compartment and close the cover. Adjust the wavelength to approximately 850 nm.

2. Verify the instrument is in Constant On mode by pressing SHIFT, SETUP, then press the DOWN ARROW key twice. If lamp: is in **Constant On** mode, go to Step 3. If it is in **Momentary** mode, put the instrument in **Constant On** mode by pressing ENTER, then press the UP ARROW key to toggle to **Constant On**. Press ENTER again.

3. While still in the Setup Menu, press the UP ARROW key to scroll to **Adjust nm:** and press ENTER. The display will show: **Peak Filter**. Press ENTER again. The display will show: **Zero Required**

4. Press the ENTER key. The display will show: **100.0 %T Peak Filter**

5. Place the calibration filter into the sample compartment with the tab aligned to the right. Close the cover.

6. Using the wavelength control on the side of the instrument, slowly adjust the wavelength dial counterclockwise (decreasing wavelength) while observing the transmittance reading in the display. Record the wavelength (nm) where the % transmittance reading is greatest. Turn the wavelength dial back in the other direction to at least 10 nm higher than the value recorded above. Again adjust the wavelength dial counterclockwise slowly while watching the % transmittance display. Stop exactly on the peak (highest) transmittance value. You may now adjust the calibration.

Note: *Repeat Step 6 as needed until you have stopped dialing exactly on the peak transmittance reading when approaching from the higher wavelength side (counterclockwise direction).*

7. With the peak transmittance determined in Step 6 displayed, press ENTER. The display shows **ARE YOU SURE?**.

8. Press ENTER. A good adjustment gives a momentary display of **Completed** with 808 in the nm field, and then reverts to the **Enter Program #** display. If you are unable to obtain a good adjustment, contact the Hach service center serving you.

If you do not have a Lamp Calibration Filter and/or wish to use the factory default setting, press SHIFT, SETUP, then press the UP ARROW key twice so the display shows **Adjust nm:**. Press ENTER. Then press the UP ARROW key once to display **Default Setup:** and press ENTER again. Press EXIT twice to get back to the **Enter Program #** prompt.

SECTION 6 TROUBLESHOOTING

6.1 Introduction

Correcting problem conditions with the DR/2010 Spectrophotometer in the field is limited to responding to the error messages presented in the display. Other problems must be handled by a Hach technician at a service center. Refer to *REPAIR SERVICE*. **Do not** attempt to service anything other than battery and lamp replacement. There are no other field-serviceable parts. Opening the instrument case voids the warranty.

6.2 Operational Messages

6.2.1 **********

When a key is pressed that calls for the instrument to perform a function it cannot do at that time, a string of 16 asterisks appears in the display momentarily, and, if the beeper is activated, three beeps sound.

6.2.2 No Program XXX

If an unavailable program number is keyed in, **No Program xxx** is displayed. A mis-keyed number may be the cause. Program numbers must range from 0 to 899 (Hach programs) and 950 to 999 (user programs). Entering a number outside the range for these procedures results in the incorrect number message. When this error message displays, re-enter the proper number, or scroll to the desired program or option.

6.2.3 Lid Open

The LID OPEN? display is most likely to occur if the cell compartment is not covered during the self-test or zeroing. Close the cover or use the light shield cap and repeat the step by pressing **ENTER**. This message also occurs when the cover is open when the instrument is turned on. Closing the cover, using the light shield cap, or installing the Pour-Thru cell is recommended when the instrument is turned on.

6.2.4 Lamp Out

The LAMP OUT? message occurs when insufficient light is present to take a measurement. It may be caused by:

- a faulty lamp
- an improperly positioned lamp
- an adapter placed incorrectly in the cell compartment
- a dark sample in the cell compartment during zeroing
- low lamp voltage
- some other electronic problem.

Investigate each possibility, beginning with those relating to operator methodology. If the **LAMP OUT?** display cannot be corrected, contact the Hach service center or distributor serving you.

6.2.5 Concentration Out Of Range

An out-of-range condition is indicated by the flashing **Over Range** or **Under Range**. It means the sample concentration exceeds the range of the programmed calibration. Make sure the test procedure is followed correctly, dilute the sample (for over range samples) and rerun the test. Each Hach test has an upper concentration value that defines the program range. Measurements beyond that range are unreliable.

6.2.6 Low Battery

The instrument continuously monitors battery voltage. If the battery voltage falls to a level indicating less than ten percent battery life remains, the instrument automatically warns the operator at one minute intervals by beeping and displaying the following message for two seconds, and then returns the display to normal operation.

710 NM
LOW BATTERY

When the battery voltage falls below 7.2 volts, the instrument automatically switches to the momentary mode to conserve battery life. If the voltage measures less than 7.0 volts when the instrument is turned on, the instrument beeps, displays **LOW BATTERY** and turns off. Replace the batteries, or, if a rechargeable battery is installed, recharge as soon as possible (refer to section *4.1 Battery Installation*).

Manually check the condition of the battery power source at any time by pressing SHIFT BATT. The battery voltage is displayed in the large digits and a bar graph indication of the battery life is displayed in the text section of the display.

For example:

710 nm
8.00 ========

indicates a battery voltage of 8.0 volts and a battery life indication bar (running half the width of the 16-character section) indicates approximately half its charge remains. The battery check display is momentary, and the display showing when the SHIFT BATT keys were pressed is restored.

6.3 Warning Displays

If the instrument encounters a problem with marginal offsets, fails to zero or experiences other problems during operation, one or more of the following messages may be displayed:

OFFSET
ZERO
INSTRUMENT

If this occurs, press ENTER to repeat the tests. If the repeat test fails, contact Hach Service.

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

REPLACEMENT PARTS

REQUIRED APPARATUS

Description	Unit	Cat. No.
Adapter, AccuVac Vial	each	43784-00
Adapter Kit, COD Vial	each	44799-00
Adapter Kit, Immunoassay tube	each	46820-00
Adapter Kit, test tube, 13-mm	each	44798-00
Battery Eliminator/Charger, 95-240 Vac, UL/CSA approved	each	49346-00
Battery Holder, for 6 D cells	each	44866-00
Calibration Filter Assembly (includes Filter Assembly and Instructions)	each	46646-00
Cell Riser, 10-mL sample cell	each	45282-00
Dust Cover, DR/2010	each	25624-00
Manual Set, includes Instrument and Procedure manuals & 3-ring binder	each	49300-77
Outdoor Light Shield	each	46878-00
Power Cord, 18/3 SVT 7.5 ft, 10A-125Vac for North American use	each	18010-00
Power Cord, .75mm SQx3 conductor, 8 ft, for European 250 Vac use	each	46836-00
Sample Cells, 1-inch, 25 mL, matched pair	pair	20950-00
Sample Cells, 1-inch, 10-mL, matched pair	pair	24954-02
Zeroing Vial, AccuVac, w/cap	each	21228-00

OPTIONAL ACCESSORIES

Description	Unit	Cat. No.
Adapter, 1-cm cuvette	each	44895-00
Batteries, D size, pkg of 4	each	11494-54
Battery, NiCad, rechargeable, for PN60 printer	each	26688-00
Battery, rechargeable, 8V	each	45185-00
Carrying Case, for DR/2010	each	30331-00
HachLink Software	each	49665-00
Lamp Replacement Kit, includes:	each	46644-00
Lamp Assembly	each	46647-00
Calibration Filter Assembly	each	46646-00
Pour-Thru Cell Kit, 1-inch	each	45215-00
Pour -Thru Cell Kit, 1-cm	each	49314-00
RS232 Interface Cable	each	48129-00
Printer, 115/230 V, Citizen, PN60	each	26687-00
Printer Cable Assembly	each	26689-00
Printer Ink Cartridge, for PN60 Citizen Printer, black	2/pkg	26690-00
Sample Cell, 1-inch, unmatched pair	pair	13537-02
Sample Cells, 1-cm, matched pair	pair	20951-00
Sample Cells, disposable, 1-inch polystyrene, with caps	pkg/12	24102-12

HOW TO ORDER

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389
U.S.A.
Ordering information by E-mail:
orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

In Europe, the Middle East, or Mediterranean Africa:
Hach Europe, S.A./N.V.; Namur, Belgium
Telephone: (32)(8l) 44.71.71; FAX: (32)(81) 44.13.00

In Canada, Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa (except Mediterranean Africa), or the Pacific Basin:
Hach Company World Headquarters; Loveland, Colorado, U.S.A.
Telephone: (970) 669-3050; FAX: (970) 669-2932

REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:
Hach Company
100 Dayton Ave.
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Europe, the Middle East, or in Mediterranean Africa:
Hach Europe, S.A./N.V.
Chaussée de Namur, 1
B-5150 Floriffoux (Namur), Belgium
Telephone: (32)(8l) 44.71.71
FAX: (32)(81) 44.13.00

In Latin America, the Caribbean,
the Far East, the Indian Subcontinent,
Africa (except Mediterranean Africa) or Pacific Basin:
Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932

WARRANTY

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES: Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specifications, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company's warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

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